Appendix D
Estimating Section 7 Impacts and Costs

This appendix describes in detail each type of activity (and sub-activity, where applicable) included in the analysis:

- Hydropower dams
- Non-hydropower dams and other water supply structures
- Federal lands management, including grazing (considered separately)
- Transportation projects
- Utility line projects
- Instream activities, including dredging (considered separately)
- EPA NPDES-permitted activities
- Sand and gravel mining
- Residential and commercial development

In each case, the following is described:

- The nature of the activity;
- Any potential modifications necessary to comply with section 7 for the protection of Pacific salmon and O. mykiss;
- The range of costs associated with those modifications;
- The methods for estimating the occurrence of the activity over space and time; and
- The likelihood that an activity will require modification.

The assumptions and possible biases for the analysis for each type of activity is also presented in this Appendix.

Because the data sources for the cost estimates do not constitute a random sample, this analysis does not use an average over the range of estimated costs. It therefore assumes that the endpoints of the range represent the minimum and maximum values of a symmetric cost distribution, and employs the midpoint of the range as the representative cost estimate.

This appendix supports the analysis for both the seven California salmon O. mykiss ESUs as well as the 13 Pacific Northwest ESUs. For that reason, the appendix contains references to data and methods specific to the Northwest Region, although the results for the Pacific Northwest ESUs are not included in the other parts of this analysis.

This appendix first discusses the method used for obtaining estimates of the annual expected modification cost. It then discusses the application of this method to each activity type. Finally, this appendix presents a summary table for all activity types.

D 1. Method for estimating annual expected modification costs

The cost assessment method involves the following components:

1) **Modification cost stream**
If a project needs to be modified to comply with section 7, this analysis assumes that the expenditures on those modifications begin today (year 0) and extend through year τ. This gives a stream of expenditures or costs, $\{C_0, \ldots, C_\tau\}$. In most cases, this analysis assumes $\tau = 0$ – that is, the costs are incurred in a single year. In other cases, costs may consist of capital costs that occur in the first year and O&M costs that occur in subsequent years. In still others, the costs may be capital costs that are spread out over a number of years.

2) **Forecast period for consultation**
This is the period over which each type of activity that may need to be modified to comply with section 7 is projected. The length of the period, T, is determined by one or both of two factors: the nature of the activity (e.g., FERC-licensed dams) and the nature of the data. In some cases, professional judgment defined this period.

3) **Probability of project modifications during the forecast period**
This probability has two components:

1) The probability, p_t, that consultation will occur in year t, where $0 \le t \le T$.
2) The probability, p_M, that consultation will result in a requirement to modify the project.

This analysis assumes that p_M is independent of t, and so the probability of project modifications beginning in year t is $p_M p_t$.

Using these three components, the calculation of the annual expected modification cost proceeds as follows:

Step 1: Calculate the present value of the cost stream
The stream of costs, $\{C_i\}$, is used to calculate the present value, using the discount rate, r :

(1)
$$PV_C = \sum_{i=0}^{\tau} \frac{C_i}{(1+r)^i}$$

PV_C is the estimated present value of costs incurred if modifications are required.

Step 2: Calculate the expected value of costs over the forecast period

This analysis applies the probabilities of consultation and modification in year *t* to the present value of costs to get the expected value of costs for year *t*, $EC_t = p_t p_M PV_C$. It then calculates the present value of this expected cost, PV_{EC}, over the forecast period, using the discount rate, *r* :

(2)
$$PV_{EC} = \sum_{t=0}^{T} \frac{EC_t}{(1+r)^t} = \sum_{t=0}^{T} \frac{p_t p_M PV_E}{(1+r)^t}$$

Step 3: Annualization of PV_{EC}

Because *T* varies across activities, modification costs are expressed as an annual expected value, AEV_C, using the standard formula for annualization:

(3)
$$\boldsymbol{AEV_C = PV_{EC}\left[\frac{r}{1-(1+r)^{-T}}\right]}$$

In general, AEV_C depends on the discount rate, *r*, in a complex way, as *r* affects both the annualization and the embedded present value of costs, PV_C. If p_t is uniformly distributed throughout the forecast period, however, $p_t = 1/T$. In that case, $p_t p_M PV_C = (p_M PV_C)/T$, which is constant over time. This result in the following:

(4)
$$\boldsymbol{AEV_C = p_M PV_C / T.}$$

Moreover, if expenditures occur in a single year, then $PV_C = C_0$, which is independent of the discount rate. In this case, $AEV_C = p_M C_0$ will also be independent of the discount rate.

AEV_C is used to express the cost of section 7 impacts. In Section 5 of the report, this annual value is projected over a 20-year period to give a picture of the present value of the costs, but the annual value is the most accurate estimate, given the wide range in forecast periods.

An important assumption embedded in this method is that AEV_C is independent of the area or extent of the critical habitat designation. This is equivalent to assuming that the cumulative impacts of

critical habitat designation are minimal. If this assumption is violated, the designation may raise market prices, which are used to evaluate the costs of the impacts. If this happens, the number (and order) of watersheds designated will affect the assessment of a given watershed's impacts.[1]

This possibility raises a difficult analytical issue. If cumulative impacts are present, the analysis should then conducted either as a series of individual watershed designations with a fixed order, or more generally as a combination of watersheds, ranging over all possibility combinations. Even if data existed on cumulative effects, the possible combinations quickly become intractable .[2]

Although there is no evidence that cumulative impacts are present and significant, this analysis notes that the assumption they are absent introduces a potential bias in the results. If the assumption is violated, the estimates used are biased downward, in that the cumulative impacts would likely increase the cost of critical habitat designation above the levels estimated.

D 2. Hydropower Dams

D 2.1 Overview

- This analysis assesses impacts to hydropower projects that may result from future section 7 implementation for Pacific salmon and O. mykiss within the proposed critical habitat. Hydropower-related activities include operations, maintenance, construction and deconstruction of hydropower facilities including licensing/relicensing, modifications to infrastructure, changes in operation, and removal of dams. A review of recent consultation history shows that approximately five percent of section 7 consultations in the Northwest Region for Pacific salmon and O. mykiss are conducted on various hydropower-related activities.

- This analysis assigns a per-project cost estimate based on the likely suite of modifications to infrastructure and operations that may be required in order to comply with the Endangered Species Act (ESA) for Pacific salmon and O. mykiss. The primary modifications analyzed are change to flow regime (either level of flow or timing of flow), construction or improvements to fish passage facilities and programs, research and monitoring of water quality and fish passage

[1] The problem is akin to identifying the "deciding vote" in an election that is won by a single vote. Any voter can lay claim to being the "deciding voter", as without that vote the election outcome would have been reversed. Only if votes are cast in a certain, fixed order could this claim be legitimate. Similarly, if market prices rise as designations accumulate, this effect can be attributed to any one of the watersheds being designated. The impact of designating a particular watershed, then, may be significantly different if the designation is the "first" or the "last."

[2] The number of possible designations, where each individual watershed cycles between included and excluded, increases exponentially as the number of watersheds increases. For example, the Hood Canal summer-run chum salmon ESU has 17 individual areas under consideration, which produces over 130,000 possible combinations; the Puget Sound chinook salmon ESU, with 80 watersheds, has 1.2×10^{24} possible combinations; and the Snake River O. mykiss ESU, with 287 watersheds, has 2.5×10^{86} possible combinations.

efficiency, and offsite mitigation, such as land purchases for the purpose of conservation. While data regarding anticipated costs stemming from changes in flow regime for particular projects are presented, this category of costs is not integrated with the impact assessment due to the uncertainty surrounding the potential magnitude of costs, and the difficulty in attributing these costs to the designation of a particular area as critical habitat.

- Where information is available on the likely project modifications recommended for a particular project, the anticipated costs are assigned to that dam. For all other projects, annualized expected costs of project modification are assigned according to two project attributes: (1) size of project based on level of installed capacity; and (2) status of fish passage provisions. The following are the per-project costs of modifications associated with the various types of hydropower projects:

  - Installed capacity of less than five megawatts (MW): $2.1 million[3] ($24,000 - $4.2 million)

  - Installed capacity between five and 20 MW: $5.76 million ($0 - $11.5 million)

  - Installed capacity of greater than 20 MW; Fish passage provisions may be required: $73.85 million ($11.5 to $136.0 million)

  - Installed capacity of greater than 20 MW; Fish passage provisions are already present: $45.23 million ($11.5 to $79.1 million)

  - Installed capacity unknown: $7.53 million ($0 to $136.0 million)[4]

- While costs were estimated for Federal Columbia River Power System (FCRPS) projects, Central Valley Project (CVP) projects, and projects within the mainstem Columbia, Snake, and Sacramento Rivers, cost estimates were not assigned to individual watersheds.

- For FERC-licensed dams, section 7 consultation and subsequent project modification are anticipated to begin concurrent with the expiration of the current FERC license, or, in the absence of that information, this analysis assumes consultation will be initiated within the next 30 years based on the fact that FERC licenses typically last 30 to 50 years. This analysis assumes that consultation for each Federal project will occur sometime within the next ten years. For small

[3] Projects are assumed to have a ten percent likelihood of bearing these costs due to consultation.

[4] The midpoint estimate is estimated by summing the product of the estimated probability that a dam with an unknown capacity could belong to one of the known capacity categories and the midpoint cost estimate for the appropriate capacity category.

projects, this analysis assumes consultation has a ten percent chance of occurring at some point over the next 20 years. For the majority of hydropower projects, the costs of project modifications are assumed to be incurred uniformly over a ten year time period beginning in the year of section 7 consultation.

D 2.2 Background

Hydropower activities have represented a relatively small percentage of section 7 consultations regarding Pacific salmon and O. mykiss in the past.[5] The consultations that have occurred, however, have at times been controversial and costly. For example, consultation regarding review of the Federal Columbia River Power System (FCRPS) operations occurs on a five year schedule. The 2000 Biological Opinion on the FCRPS has been the subject of litigation challenging the adequacy of the project modification recommendations to provide for Pacific salmon and O. mykiss.[6]

Hydropower activities that generate consultation regarding Pacific salmon and O. mykiss include licensing or relicensing of projects, review of operations plans, construction of new projects, modifications to structures of dams (e.g., installation of fish passage facilities), changes in operations (e.g., change in flow regime), and removal of dams. The major Federal agencies responsible for hydropower activities in the areas under consideration are the Federal Energy Regulatory Commission (FERC), U.S. Army Corps of Engineers (USACE), the U.S. Bureau of Reclamation (USBR) and the Bonneville Power Administration (BPA). FERC issues licenses for privately owned hydropower projects and these licenses are valid for between 30 and 50 years depending on the extent of proposed new development or environmental mitigation and enhancement measures. The USACE and USBR also own and/or operate hydropower projects within the proposed critical habitat for Pacific salmon and O. mykiss. A collaborative group comprised of the BPA, USACE, and USBR oversees operations of the 31 multipurpose dams of the FCRPS. While there is no formal procedure for regular review of Federally-operated projects, any change in operations or existing infrastructure may generate consultation regarding the impact to Pacific salmon and O. mykiss.

Multiple hydropower-related Federal and State regulations provide protection to Pacific salmon and O. mykiss. Specifically, section 10(j) of the Federal Power Act (FPA) was promulgated to ensure that FERC considers both power and non-power resources during the licensing process.[7] Further, section 18 of the FPA states that FERC shall require the construction, operation, and maintenance by a licensee at its own expense of a fishway if prescribed by the Secretaries of Interior (delegated to the Service) and Commerce (NOAA Fisheries). The Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act) also incorporates a Fish and Wildlife Program directing the Pacific Northwest Electric Power and Conservation Planning Council to adopt programs to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and

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[5] Within the Northwest region, hydropower projects represent approximately five percent of historical section 7 formal consultations.

[6] *National Wildlife Fed'n, et al. v. Nat'l Marine Fisheries Serv., et al.*, 254 F. Supp.2d 1196 (W.D.Wa. 2003) (order finding the no-jeopardy conclusion in the 2000 plan to be arbitrary and capricious).

[7] Federal Power Act, 16 U.S.C. § 803(j) (1986).

habitat, on the Columbia River system. BPA resources are utilized through this plan to mitigate and enhance fish and wildlife and habitat affected by the development and operation of hydroelectric projects in the Columbia River and it tributaries.[8]

Reasonable and prudent alternatives (RPAs) recommended through consultation regarding hydropower projects may be broadly divided into three major categories: operational, capital, and programmatic. Operational changes include changes in hydropower production level or method, and may be engendered by modification to flow regime.[9] Capital modifications involve direct investment in new or improved infrastructure, and require additional investment for regular operation and maintenance.[10] Programmatic changes include all other types of modification including monitoring of fish passage efficiency and water quality, data collection and research, operation of fish hatcheries, predator control, habitat improvements or restoration, and purchase of land and water rights.[11]

D 2.3 Cost Assessment

This analysis uses the current operations and existing structures of projects as a baseline for assessing the costs of modifications. Costs of RPAs for specific dams that have been recommended and implemented through past consultations are therefore not included as costs of section 7 implementation. This base case establishes the level of modification to existing operations and facilities that may be recommended through section 7 consultation in the future. Cost estimates for RPAs likely to be imposed in the future are based on a review of past economic studies, surveys of hydropower project operators, and available industry expenditure data.

The potential costs of project modifications are estimated for more than 370 hydropower projects in California, Idaho, Oregon, and Washington. As part of this effort, utility companies and Public Utility Districts (PUDs) were contacted regarding the costs of anticipated project modifications to comply with the ESA for Pacific salmon and O. mykiss. Where project-specific costs were available from these contacts (17 projects in the Northwest Region), these precise costs are employed in the analysis. Total per-project costs for these projects range from approximately $162 thousand to $136 million.

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[8] Pacific Northwest Electric Power Planning and Conservation Act, 16 U.S.C. §§ 839-839h.

[9] From a review of historical section 7 consultations regarding hydropower activities, recommended operational changes include: improve and manage flows through additional flow augmentation; reduce flow diversions; provide spill to increase fish passage efficiency; operate pools within a specified range; operate turbines within a specified range of efficiency; shut down turbines seasonally; draw down reservoirs; and implement restrictions on ramping rates.

[10] From a review of historical section 7 consultations regarding hydropower activities, capital modifications include: constructing and maintaining fish passage facilities (including ladders and screens where applicable); collection and transport of fish at particular sites; installing improved juvenile sampling facilities, surface bypass collectors, and/or spillway weirs.

[11] Programmatic changes from a review of a number of historical section 7 consultations include: implementing or improving capture and release programs (e.g., enlarging transport barge exits); monitoring, evaluation, and research programs; gas abatement programs; participation in research initiatives (e.g., investigating bypass improvement methods); managing riparian vegetation; controlling erosion and sediment; implementing timing constraints on instream construction; and increased pollution control standards.

Five hydropower projects in the Northwest Region within the proposed designation are currently slated for removal. These projects are anticipated to bear a one time cost of $24 million in capital costs of deconstruction ($18 million) and land donation ($6 million).[12]

For other cases, where information on the specific per-project costs associated with section 7 implementation were not available, this analysis estimates the likely suite of project modifications that may be recommended based on review of historical consultations. This analysis aggregated the costs associated with these project modifications to determine potential ranges in total cost associated with section 7 implementation. To refine these estimates, hydropower projects were divided into six cost categories based on their relative level of power generation, and status of fish passage provisions.

For the majority of projects, the costs of project modifications are assumed to be incurred uniformly over a ten year time period beginning in the year of potential section 7 consultation. There are four exceptions to this rule: (1) dam removal costs are anticipated to occur in a single year, the year of decommissioning and deconstruction; (2) costs associated with small projects are assumed to occur in one year to be consistent with the treatment of non-hydropower dams; and (3) project modification costs associated with 11 of the projects employ a specific cost allocation formula provided by the project owners.[13] The present value of the cost estimates for each category are described in Table D-1.

Not included in the per-project cost estimate is the potential economic impact of certain operational changes. Recommendations to augment flow or change the timing of flow through a project to facilitate fish passage can have significant economic impacts on a hydropower dam. Demand for power varies seasonally, thus the value of power changes throughout the year. To the extent that flow augmentation requires water to be passed at times of the year when it is less valuable, there may be an associated economic cost. Also, where fish passage through the dam is an issue, seasonal spill over of the dam may be required to reduce the risk of fatality associated with passage through the turbines. In this case, the spilled water no longer passes through the turbines and therefore cannot be used to generate electricity. The costs of more expensive electricity may be passed on to the power consumers in the form of rate changes.[14] Table D-2 highlights examples of anticipated cost impacts associated with flow regime changes for Pacific salmon and O. mykiss at various projects throughout the designation.

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[12] Based on anticipated costs of dam decommissioning and removal of the Sandy River Project from an interview with Portland General Electric (2003).

[13] For these projects, four percent of costs occur each year for 2004 through 2018, two percent of costs occur each year from 2019 through 2033, and 0.5 percent of costs each year from 2034 through 2053, survey of Portland General Electric, December 2003.

[14] Lon Peters, Memorandum to Industrial Economics, Inc. "ESA Costs for the Hydropower Sector." November 18, 2003.

Table D-1 Estimated Costs of Project Modifications for Hydropower Dams			
Project Category (# of dams)	**Installed Capacity of Project (MW)**	**Status of Fish Passage**	**Estimated Per-Project Costs of Modifications**
1 (231 dams)	less than 5	N/A	**Present Value of Cost: $2.1 million ($24,000 - $4.2 million)** According to FERC guidelines, hydroelectric projects with an installed capacity of less than five megawatts (MW) may be exempted from the licensing process.[c] Because these projects are not currently generating power, or are generating power in small amounts, estimated costs are based on the project modification costs of non-hydropower dams, which are anticipated to range between from $24,000 to approximately $4.2 million. Each of these projects is assigned a ten percent probability of incurring these costs sometime during the next twenty years.
2 (24 dams)	between 5 and 20	N/A	**Present Value of Cost: $5.75 million ($0 to $11.5 million)** The high-end of this estimate comprises: - capital costs, such as facilities improvements, of $8 million; - species surveys at $2,600 per year for ten years; - research on species survival and passage efficiency at $150,000 per year for ten years; and - water quality monitoring at $200,000 per year for ten years. The low end is for a project where no modifications are required.

Table D-1 Estimated Costs of Project Modifications for Hydropower Dams			
Project Category (# of dams)	**Installed Capacity of Project (MW)**	**Status of Fish Passage**	**Estimated Per-Project Costs of Modifications**
3 (10 dams)	greater than 20	none	**Present Value of Cost: $73.75 million ($11.5 - $136.0 million)** The low end of the range includes: - Species surveys at $2,600 per year for ten years (Bonneville Power Administration. Fish and Wildlife Group. "Implement Willamette Basin Mitigation Project." BPA Project Number 199206800); - Capital costs, such as facilities improvements, of $8 million, from a survey of 17 hydropower projects in the Northwest United States; - Research on species survival and passage efficiency at $150,000 per year for ten years (Huppert, Daniel D., Davil L. Fluharty, Eric E. Doyle, and Amjoun Benyounes. Economics of Snake River Salmon Recovery: A Report to National Marine Fisheries Service. October 1996.); and - Water quality monitoring at $200,000 per year for ten years (Huppert et. al., 1996). The high-end of the cost range is the high-end for project modifications to a hydropower project from a December 2003 survey of utility companies and Public Utility Districts in the Pacific Northwest. The estimate includes annual costs of fish-related operations (hatchery and spawning operations, predator control studies, fish ladders and operations, fish survival studies, etc.), fish-related maintenance (fish ladder and bypass maintenance), and associated debt services (surface collector, diversion screens juvenile fish bypass system, etc.) projected over ten years. Not included is the market value of lost power generation as a result of modifications to project operation.

Table D-1 Estimated Costs of Project Modifications for Hydropower Dams			
Project Category (# of dams)	**Installed Capacity of Project (MW)**	**Status of Fish Passage**	**Estimated Per-Project Costs of Modifications**
4 (8 dams)	greater than 20	present or not needed	**Present Value of Cost: $45.3 million ($11.5 - $79.1 million)** Where passage facilities were determined to be present or not required, the average costs of related operations and maintenance of these facilities was removed from the high-end estimate in the cost range (i.e., high-end estimate of $136 million less approximately $57 million over ten years of fish passage-related costs) These costs originate from a December 2003 survey of utility companies and Public Utility Districts in the Pacific Northwest.[b]
5 (16 dams)	greater than 20	unknown	**Present Value of Cost: $56.4 million ($11.5 - $136 million)** In the absence of information regarding the presence of fish passage (as is common for the California hydro projects), this estimate reflects the probability of the presence of fish passage based on data from the Northwest Region. In the Northwest, approximately 61 percent of projects with installed capacities greater than 20 MW currently have or do not require fish passage facilities, and 39 percent either do not have facilities or the status is unknown.

Table D-1
Estimated Costs of Project Modifications for Hydropower Dams

Project Category (# of dams)	Installed Capacity of Project (MW)	Status of Fish Passage	Estimated Per-Project Costs of Modifications
6 (35 dams)	unknown	unknown	**Present Value of Cost: $7.53 million ($0 to $136.0 million)** Where installed capacity is unknown, the cost estimate reflects the likelihood of the project having various levels of installed capacity, based on the data from the Northwest, as well as the likelihood that the project will need modifications (10% for projects with installed capacity less than 5MW). In the Northwest region, 81.2% of dams have i.c. of less than 5MW, 6.4% have i.c. between 5 and 20, and 12.4% have i.c. greater than 20MW. These probabilities were applied to the midpoint estimates above to arrive at this cost estimate.

[a] Data on installed capacity of projects and status of fish passage is from the Pacific Northwest Hydropower Database and Analysis System.
[b] The recommendation to install or improve a fish ladder may be brought about through consultation under section 7 of the ESA or through the Federal Power Act. This analysis quantifies the cost of this modification as coextensive with the designation of critical habitat, although in the absence of the designation, the FPA may obligate construction of an adequate fishway.
[c] Federal Energy Regulatory Commission, Hydroelectric Project Licensing Handbook, April 2001.

Table D-2 Economic Impacts Associated with Hydropower Dam Flow Regime Changes			
Hydropower Project	**Description of Cost**	**Estimated Annual Cost of Changes to Flow Regime**	**Source**
Rocky Reach Dam	Market Value of Lost Power Generation	$7,130,000	Chelan County Public Utility District February 2004
Rock Island Dam	Market Value of Lost Power Generation	$8,480,000	Chelan County Public Utility District February 2004
John Day Dam	Cost of replacement power from lost power generation associated with dam drawdown	$100,800,000	Huppert, Daniel D., Davil L. Fluharty, Eric E. Doyle, and Amjoun Benyounes. Economics of Snake River Salmon Recovery: A Report to National Marine Fisheries Service. October 1996.
Wanapum Dam	Cost of loss generation due to increased summer spill	$80,000,000	"Grant PUD Meets Survival Goals at Two Mid-Columbia Dams." Columbia Basin Bulletin. September 26, 2003.

The necessity, level, and method of flow regime changes accommodate the biological needs of Pacific salmon and O. mykiss at a particular project are determined on a case by case basis. Further, the economic impact associated with a flow regime change is dependent upon the type of project. For example, replacing power generated by peaking projects (i.e., projects that produce hydropower during periods of highest demand) is more expensive than replacing base power production. Until a hydropower project operation is reviewed, the type and level of flow changes necessary and feasible for species and habitat protection is speculative, and so the data needed to estimate these impacts are not available. ***Because of this, the economic impacts resulting from changes in flow regime are not included in the cost ranges associated with each project.*** This likely leads to an understatement of total impacts associated with section 7 implementation for some or all of the ESUs.

Projects belonging to the Federal Columbia River Power System comprise a unique category. Of the 31 FCRPS hydropower projects, 22 fall within the boundaries of the potential critical habitat for Pacific salmon and O. mykiss, but all projects may adversely affect that habitat through their operations.[15] The implementation of section 7 for the 13 Pacific salmon and O. mykiss ESUs under consideration has had significant impacts on the FCRPS, both in terms of capital structures and operations.[16] Attributing these impacts to the designation of critical habitat for a "particular area," however, is problematic for at least two reasons. First, NOAA Fisheries implements section 7 for the FCRPS at the system level, in that the agency applies the jeopardy standard to the system as a whole, not to the operation of individual constituent parts. Because the system spans dozens ofwatersheds, it is not possible to assign section 7 impacts on an area-by-area basis. Second, the FCRPS is operated as an optimized system subject to constraints, where the optimization involves multiple objectives. The impact of section 7 of the ESA is to add a constraint on the system's operation. Because the scale of the FCRPS is so large, this constraint cannot be attributed to a "particular area" on the scale of a individual watershed. Changing the amount or timing of flow at one dam, for example, will produce changes at other dams as the system is adjusted in light of a new constraint. For these reasons, the impacts of section 7 and critical habitat designation on the FCRPS are included in the NWR analysis, but the impacts are not divided on a watershed per watershed basis. As a result, these impacts are treated as an impact of section 7 for the designation of critical habitat, but not an impact of designating a particular watershed as critical habitat.

D 2.4 Spatial and Temporal Distribution of Activity

This analysis uses latitude and longitude data from the Pacific Northwest Hydrosite Database (Bonneville Power Association) to locate hydropower dams in the Northwest region, augmenting those data with geospatial data from USACE National Inventory of Dams.[17] Latitude and longitude of hydroelectric projects in the Southwest region are from the USACE National Inventory of Dams and the California Department of Water Resources, Bulletin 17.[18]

In order to determine the likely date of consultation for a dam, a series of assumptions were made based on the nature of the Federal nexus. For FERC-licensed dams, section 7 consultation and subsequent project modification are anticipated to begin concurrent with the expiration of the current FERC license as part of the relicensing process. Federal dams are not subject to FERC relicensing and, as such, operations may not be reviewed on a standard schedule. This analysis assumes that consultation for each Federal project will occur sometime within the next ten years. This analysis

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[15] USBR, USACE, BPA. Endangered Species Act 2003 Check-In Report for the Federal Columbia River Power System. September 2003.

[16] Section 7 of the ESA was first applied to the FCRPS in 1995, which predates the listing of the 13 ESUs under consideration. The ESUs covered in that biological opinion were Snake River sockeye salmon, Snake River spring/summer chinook salmon, and Snake River fall chinook salmon.

[17] Bonneville Power Administration, The Pacific Northwest Hydropower Database and Analysis System (NWHS); USACE, National Inventory of Dams, accessed at http://crunch.tec.army.mil/nid/webpages/nid.cfm.

[18] California Department of Water Resources, Division of Safety of Dams. Dams within the Jurisdiction of the State of California, Bulletin 17.

assumes the probability that the consultation will occur in a given year is uniformly distributed through this period (i.e, a consultation has a ten percent probability of occurring in any given year). For small projects, consultation is assumed to have a ten percent chance of occurring at all over the next 20 years (consistent with the treatment of non-hydropower dams), with the annual probability uniformly distributed through this period.

Limited data exist regarding FERC relicensing schedules for hydroelectric projects in the SWR. Where this information is not available, this analysis conservatively assumes that consultation will be initiated within next 30 years due to the fact that FERC licenses typically last 30 to 50 years. For these projects, this analysis assigns an equal probability to consultation beginning in each year over the next 30 years.

D 2.5 Annual Expected Modification Cost Estimates

Unlike most other activity types, the cost estimates for hydropower dams are a mix of specific cost information for some dams and general estimates for the others. Table D-3 illustrates the annual expected modification costs for the general estimates associated with each cost category as described in Table D-1.

Table D-3
Estimated Annual Expected Per-Project Costs for Hydropower Dams

Activity	Sub-activity	Present Value of Costs	Annual Expected Cost
Hydropower Dams	Installed capacity is less than 5MW	$2,120,000	$10,600
	Installed capacity between 5 and 20 MW	$5,750,000	$115,000
	Installed capacity is greater than 20MW; fish passage may be required	$73,850,000	$1,477,000
	Installed capacity is greater than 20MW; fish passage already present or unnecessary	$45,230,000	$904,600
	Installed capacity is greater than 20 MW; fish passage status is unknown	$56,390,000	$1,127,800
	Installed capacity unknown	$7,400,000	$246,667

Table D-3 Estimated Annual Expected Per-Project Costs for Hydropower Dams			
Activity	**Sub-activity**	**Present Value of Costs**	**Annual Expected Cost**
Because 17 projects were assigned project-specific modification cost estimates, they are not included in this table. Also, the dams slated for removal are also not included in this table, as the date for removal is known in each case. In both cases, the costs are included in the estimated impacts for the corresponding watershed.			

D 2.6 Assumptions and Potential Biases

Table D-4 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-4 Hydropower Dams: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
To estimate the expected start date for future consultation, this analysis employs a combination of methods based upon FERC relicensing schedules, operating review schedules for certain Federal dams, and a 30 year uniform probabilistic distribution of consultation for the remaining dams. In addition, it is assumed that once consultation and modifications commence, related expenditures will occur uniformly over a ten year time frame following consultation. In reality, start dates, duration, and distribution of consultations and modifications across all dams may vary from these assumptions.	+/-
This analysis assumes that the scale of the project, as determined by the level of installed capacity, is a key determinant of the level of project modification that may be required in order to meet the requirements of section 7.	+/-
Project modifications recommended in biological opinions are included in this analysis, even if they appear to overlap particular baseline elements, such as fish passage provisions.	+

Table D-4 Hydropower Dams: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
This analysis assumes that each hydropower project will experience an individual consultation. In reality, a consultation may cover more than one project. To the extent that costs of particular project modifications associated with a single consultation may be jointly borne by the project owners, this analysis may overstate its costs.	+
Hydropower projects may be required to provide additional flow for salmon and O. mykiss and, as a result, may experience economic impacts to the extent that increased flow results in decreased or redistribution of power generation. Specific dam projects that will be required to provide this flow, and how (e.g., spill) the flow augmentation may be achieved, are difficult to predict. The likelihood of a particular project being required to provide flow for salmon and O. mykiss will depend on many factors, including biological significance of the dam project to salmon/O. mykiss survival and recovery, the seasonality of flow, the economic importance of the dam project, whether there is public concern over the project, and other factors. As a result, costs associated with flow requirements are not included in the cost estimates.	**-**
Spatial data for hydropower projects may vary according to data source. This is due to the fact that data sources may map the location of any number of components of the project, including dam infrastructure, turbine, powerhouse, afterbay, or forebay. To the extent possible, this analysis uses the location of dam infrastructure for the spatial analysis. In addition, and primarily with respect to the SWR, no comprehensive dam location and attribute data layer exists. Certain instances have been identified where dam locations vary across different data sources. The location of every dam in the data layers has not been independently corroborated.	**0**
- : May result in an underestimate of real costs + : May result in an overestimate of real costs +/- : Has an unknown effect on estimates 0: Has no effect on the total cost estimate, but may impact the allocation of costs across watersheds.	

D 3. Non-hydropower Dams and other Water Supply Activities

D 3.1 Overview

- The analysis examines the impact of section 7 implementation for Pacific salmon and O. mykiss on both construction and improvement of water supply infrastructure for agricultural and municipal/industrial uses as well as the operation, or flow regime, of non-hydropower dams.

- Approximately three percent of the consultations on Pacific salmon and O. mykiss over the past three years were associated with water supply activities (not including consultations pertaining to dams with hydropower operations). These water supply activities include flood control activities, pumping plants, water diversions, water intake structures, and fish screen projects.

- Construction and infrastructure improvement projects have been modified in design, scope, maintenance requirements, and/or monitoring requirements as a result of section 7 consultation for Pacific salmon and O. mykiss. Water project operations have also been modified to make available minimum (sometimes maximum) instream flows for aquatic species.

- Costs of non-hydropower dam infrastructure modifications to comply with section 7 requirements are estimated to cost $2.1 million ($24,000 to $4.2 million).

- This analysis assumes that all federally regulated non-hydropower dams and dams with large reservoirs (defined as dams in the 90th percentile or higher of reservoir storage capacity) are certain to bear modification costs at some point over the next 20 years. Other non-hydropower dams are assumed to have a ten percent probability of bearing consultation costs over the next 20 years.

- Costs to provide additional water flow or change the flow regime for salmon and/or O. mykiss are difficult to estimate reliably. Data on water quantity changes attributable to section 7 implementation, now and in the future, do not exist. There also is no consensus on the flow requirements likely to be recommended in the future. Further, attributing costs to provide flow to a specific watershed is difficult because water supply constraints in one watershed often have effects that are realized throughout the water system. As a result, this analysis does not integrate costs associated with providing additional flow for salmon into the impact assessment. Contextual detail regarding these impacts is provided in Appendix E.

D 3.2 Background

Water supply activities captured in this section include actions related to flood control activities, pumping plants, water diversions, water intake structures, and fish screen projects. Generally, Federal agencies, State agencies, regional public agencies, and regional private agencies supply water to end users by means of highly developed water systems consisting of dams and reservoirs, pumping plants, power plants and aqueducts. Agriculture relies on water diversion for irrigation of crops. Municipal suppliers provide water for both commercial and residential use. For a detailed discussion of significant water projects in salmon habitat areas, refer to Appendix E.2.

Operation of the Federal water projects is subject to section 7 consultation under the ESA. In addition, because some California State Water Project (SWP) facilities are used jointly with the Federal Central Valley Project (CVP), the SWP is also subject to consultation. Also, any water supplier providing water via contract with U.S. Bureau of Reclamation (USBR) or using USBR owned or maintained infrastructure is subject to section 7 consultation under ESA. Projects associated with privately owned diversions may require a Federal permit from USACE under sections 401 or 404 of the Clean Water Act.

Consultations on non-hydropower dams and other water supply activities represent approximately three percent of the consultations that were conducted on Pacific salmon and O. mykiss during 2001-2003. Involved Federal agencies primarily included the Bureau of Reclamation, U.S. Army Corps of Engineers, Bonneville Power Administration and Natural Resources Conservation Service. Other agencies involved in water supply consultations included the Department of Housing and Urban Development, Bureau of Indian Affairs, National Parks Service, and U.S. Forest Service.

The recent historical Pacific salmon and O. mykiss consultation record suggests that the most common water supply activities resulting in section 7 consultations are related to construction or improvement of dams, diversions, and intakes. Infrastructure construction projects have been modified in their design, scope, maintenance requirements, and/or monitoring requirements in order to comply with section 7 for Pacific salmon and O. mykiss. In the past, NOAA Fisheries has stipulated that alternative project designs be developed if the proposed design is believed to jeopardize listed species or adversely modify critical habitat. Design changes may require additional engineering and planning. NOAA Fisheries has also recommended adding additional components to a project. For example, to improve habitat in the area surrounding a project, NOAA Fisheries has required rock or woody debris be added to the site. The agency has requested monitoring devices be installed or additional data be collected by the Action agency or permit applicant. NOAA Fisheries has also requested a suite of other minor facility operation and maintenance requirements.

USBR water project operations, State operations, and regional water agency operations have been modified to make available minimum (sometimes maximum) instream flows for salmon, O. mykiss, and other aquatic species. In addition, NOAA Fisheries has recommended that flow fluctuations associated with reservoir operation be minimized. The agency also has stipulated that water project

gate and pump operations be altered. Sometimes, NOAA Fisheries stipulates temperature objectives be pursued, or it may recommend research and monitoring of project operations.

The extent of flow regime changes are the most difficult to forecast. Recommended modifications are location-specific and vary according to multiple factors, including the type of facility, the purpose of the facility, the regional importance of the facility, the presence of salmon and O. mykiss, the season of use, and other factors. There also does not appear to be a consensus within NOAA Fisheries on the flow requirements likely to be recommended for individual projects.

D 3.3 Cost Assessment

The USDA Natural Resource Conservation Service (NRCS) consults with NOAA Fisheries on projects related to water withdrawal for irrigation and other agricultural projects that may affect fish habitat. Costs potentially attributable to section 7 implementation also are imposed on municipal water intake construction projects. For the latter case, specific municipal water intake construction case studies were researched. In addition, an analysis of the PNHD database suggests that costs to install fish passage and fish screens may range from $92,000 to $4.2 million. Table D-5 presents the case studies, cost categories, and specific costs identified. Because non-hydropower dam projects may bear any combination of the identified modifications, costs are estimated to range from $24,000 to $4.2 million. The midpoint of this range, $2.1 million, is used as the cost estimate, assumed to be borne over one year.

Table D-5 Case Studies of Operational Modification Costs for Nonhydropower Dams		
Case Study	**Cost Categories**	**Per-Project Costs**
Lincoln City Municipal Water Intake Project on Schooner Creek, Siletz River Basin, Lincoln County, Oregon	Engineering costs	$100,000
	Construction costs	$150,000-$220,000
	Monitoring costs	$25,000
	Habitat enhancement costs	$25,000
	Legal fees	$30,000
	Delay costs	$10,000
	Annual data collection & monitoring costs	$130,000-$260,000
City of Pendleton Water Intake and Pump Station Project, Umatilla County, Oregon	Engineering costs	$20,000
	Construction costs	$4,000
Taylor Water Treatment Intake Project, Upper Willamette River Basin, City of Corvallis, Benton County, Oregon	Construction costs	~$500,000
City of Boardman Collector Well No. 2 Project, Columbia River, Morrow County, Oregon	Flow replacement costs (One-time cost)	$100,000-$2,500,000
United States Army Corps of Engineers permitting of the proposed installation of gallery wells within the Nacimiento River, San Luis Obispo County, California	Administrative costs only	Administrative costs only
PNHD database	Fish screen and fish passage installation	$92,000 to $4.2 million
Range		$24,000 to $4.2 million

Due to the complexity of water systems present in the critical habitat re-assessment area, quantification of costs attributable to section 7 implementation on system operation (i.e., changes in flow or amount of water diverted) is difficult. A variety of data sources were considered that document the potential magnitude of costs qualitatively, including research from economic literature, engineering literature, related litigation, and data from water project environmental funding reports. Table D-6 presents an overview of the reviewed information. The table identifies the change in water quantity considered and the estimated dollar value associated with that change. Appendix E.1 presents a more detailed review of this literature.

Table D-6
Studies of Water Supply Costs Related to Water Project Operation

Case Study	Quantity of Water*	Cost
Hamilton, J. and N. Whittlesey (1996), Average Annual Costs of Flow Augmentation	4.6 MAF	$291.7 million
	3.5 MAF	$234.3 million
	3.2 MAF	$214.4 million
	1.95 MAF	$155.3 million
	1.08 MAF	$81.4 million
Huppert, D. et al. (2003), Effects on Agricultural Production as measured by Gross Revenue	1 MAF	$752.9 million
	700 KAF – 1 MAF	$476.2 – $752.9 million
	569 KAF – 1 MAF	$349.0 - $752.9 million
USBR (1999), Effects on Agricultural Production as measured by Gross Revenue	1 MAF	$90.2 - $243.7 million
CALFED Environmental Water Account, Cost of Fish Protection Measures	374,000 AF	$58.9 million
	227,000 AF	$32.14 million
*Average annual flow augmentation (MAF = million acre-feet; AF = acre-feet)		

As illustrated in Table D-6, water supply constraints can produce substantial economic impacts. Unfortunately, it is difficult to quantify and spatially distribute these impacts with any predictable degree of accuracy. While historical data exist to inform understanding of the value of the lost water or agricultural production that may result, data on water quantity changes attributable to section 7 implementation, now and in the future, are not available

In addition, it is difficult to attribute the costs of flow changes to a specific watershed. Flow changes at one point in a watershed often have biological effects that are felt downstream or even upstream.

If these effects extend beyond the border of the watershed, designation of the neighboring watershed or even others further away may trigger constraints on those activities. This means that the impact cannot be attributed to a single area's designation, but instead could come from the designation of any of a number of areas. Spreading costs equally throughout the water system is unsatisfactory, as the costs are triggered jointly, not accumulated as more watersheds are designated. ***For these reasons, the economic impacts resulting from changes in flow regime are not included in the cost ranges associated with each project.*** This likely leads to an understatement of total impacts associated with section 7 implementation for some or all of the ESUs.

D 3.4 Spatial and Temporal Distribution of Activity

Latitude and longitude data were used from the USACE National Inventory of Dams to locate dams other than hydropower projects. This database provided spatial information on 1,454 dams. Dams in the Pacific Northwest Hydrosite Database that are not currently producing hydropower and have a purpose in addition to hydropower (e.g. flood control or recreation) were also included.

Limited data exist regarding maintenance schedules for non-hydropower projects. Unlike FERC-licensed hydropower dams, nearly all non-hydropower dams lack a specific event similar to FERC licensing that would make it possible to identify an exact date for consultation. Instead, it is assumed that for most types of non-hydropower dams, a consultation will occur sometime over the next 20 years. This period was chosen based on the historic frequency of consultation for these project types. It is assumed that all federally-regulated dams and dams with large reservoirs will incur modification costs with certainty sometime during that period. A uniform distribution is used for the probability that the modifications would occur in a given year. All other non-hydropower projects are assigned a ten percent probability of incurring modification costs during this period.

D 3.5 Annual Expected Modification Cost Estimates

As noted above, this analysis assumes that modification costs are borne in one year; Federal and large non-hydropower dams are certain to bear these costs sometime during a 20 year period; and smaller non-hydropower dams have a 10% chance of bearing these costs during the 20 year period. Using the cost estimates derived above, the annual expected modification cost estimates are given below in Table D-7:

Table D-7
Estimated Annual Expected Per-Project Costs for Non-hydropower Dams

Activity	Sub-activity	Present Value of Costs	Annual Expected Cost
Non-hydropower dams	Federal and large dams	$2,120,500	$106,025
	Small non-Federal dams	$2,120,500	$10,603

D 3.6 Assumptions and Potential Biases

Table D-8 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-8
Nonhydropower Dams: Assumptions and Potential Biases

Assumption	Direction of Potential Bias
Impacts related to flow regime are difficult to model, because information concerning specific anticipated changes to flow across the designation at each relevant dam are unattainable. In addition, the specific critical habitat areas engendering changes in operations at a particular dam may be located distantly from the affected dam, and areas affected by changes in flow may be, in turn, distantly located from the dam. Thus, because impacts from changes in flow result from broad and interrelated system changes across large areas, and changes are not easily predicted, these potential impacts are not quantified in this analysis.	-
Each non-hydropower dam within critical habitat areas is assumed to be subject to some level of modification costs over the next 20 years (though in most cases, a low probability of bearing these costs is assumed). In fact, many projects may not be subject to section 7 consultations.	+
Project modifications included in biological opinions for non-hydropower dams are included in this analysis, even if they appear to overlap baseline elements. As a result, the impact of section 7 implementation over and above the baseline may be overstated.	+
Specific infrastructure costs and impacts attributable to critical habitat designation for most non-hydropower dams are not available. As a result, the cost and impacts identified are based on a relatively small sample of projects, and may not precisely capture impacts incrementally attributable to critical habitat or Section 7 of the ESA.	+/-

- : May result in an underestimate of real costs
+ : May result in an overestimate of real costs
+/- : Has an unknown effect on estimates

D 4. Federal Lands Management (including grazing)

D 4.1 Overview

- The analysis assesses impacts on Federal land management activities that will result from section 7 implementation for Pacific salmon and O. mykiss on USFS and BLM lands within areas of potential critical habitat. A review of recent consultation history shows that nearly 18 percent of section 7 consultations for Pacific salmon and O. mykiss are conducted with the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) on various land management activities.

- Since the mid-1990's, the Northwest Forest Plan and PACFISH have altered the priorities of the Federal land management agencies, and provided a strong management baseline for anadromous species protection. As a result, future impacts of section 7 implementation of the ESA, particularly in areas where the Northwest Forest Plan and PACFISH exist, are likely reduced from what they would have been absent these other protections. Nevertheless, this analysis includes project modifications as they appear in biological opinions, some of which may overlap with these baseline protections. As a result, this analysis may overstate the additional costs of section 7 implementation for Pacific salmon and O. mykiss.

- This analysis estimates section 7 costs for 10 categories of land management activities, and develop a regional per acre estimate of these annual costs across five geographic regions:

  - Idaho: $1,260 ($680 to $1,840) per 1,000 acres
  - Western Oregon/Washington: $5,900 ($3,080 to $8,710) per 1,000 acres
  - Eastern Oregon/Washington: $3,300 ($1,620 to $4,980) per 1,000 acres
  - Northern California: $8,950 ($4,910 to $12,980) per 1,000 acres
  - Southern California: $12,160 ($6,040 to $18,270) per 1,000 acres

- Impacts on livestock grazing estimated to result from future section 7 implementation for Pacific salmon and O. mykiss are $29,000 ($11,000 to $47,000) annually per 1,000 acres of grazing land**.**

- Under this methodology, watersheds containing the largest acreage of Federal lands within each geographic region will bear the highest costs associated with modifications to Federal lands management.

D 4.2 Background

A Federal nexus exists for all management activities occurring on Federal lands. Activities of the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) are grouped into one "activity" category because the agencies have many similar land management goals and regulations, and because they frequently consult together. Activities conducted by the USFS and BLM are wide-ranging, but include fuel reduction activities, road construction, road obliteration, and road maintenance, maintenance of recreation facilities, fisheries programs, timber sales[19], permitting of livestock grazing[20], and permitting of various use permits. These activities are grouped into two activity types: General land management activities (classified into ten sub-activities) and permitting of livestock grazing.

Review of the recent consultation history (2001-2003) shows that nearly 18 percent of section 7 consultations for Pacific salmon and O. mykiss are conducted with the U.S. Forest Service (USFS) and Bureau of Land Management (BLM) on various land management activities. The outcomes of these consultations are likely influenced by several important baseline regulations. In particular, the Northwest Forest Plan (NWFP) and PACFISH guidelines provide numerous baseline protections to Pacific salmon and O. mykiss.

The NWFP defines Standards and Guidelines (S&Gs) for forest use throughout the 24 million acres of Federal lands in its planning area. Specifically, the NWFP provides S&Gs for management of timber, roads, grazing, recreation, minerals, fire/fuels management, fish and wildlife management, general land management, riparian area management, watershed and habitat restoration, and research activities on USFS and BLM lands. To accomplish its goals, the NWFP defines seven land allocation categories, including "matrix lands," areas where the majority of timber is to be taken, and Riparian Reserves and Key Watersheds, where distances from rivers are set within which many activities are restricted.

For Federal lands in eastern Oregon, Washington, Idaho, and Northern California not covered by the NWFP, USFS and BLM have adopted a management strategy specifically for anadromous fish protection.[21] Like the NWFP, PACFISH provides guidelines for timber, roads, grazing, recreation, minerals, fire/fuels management, lands, riparian area, watershed and habitat restoration, and fisheries

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[19] The consultation history indicates that NOAA Fisheries consults on timber sales on Federal lands, but not on similar sales on private or other non-Federal lands. Timber sales on non-Federal lands rarely need a Federal permit, and thus do not have a Federal nexus. One section 10 Habitat Conservation Plan (HCP) exists with PALCO (Pacific Lumbier Company) and one HCP is ongoing with Simpson Timber Company on private timber activities in California. While NOAA Fisheries will consult internally on the Simpson HCP, the costs of this HCP are derived from section 10 of the Act. This analysis does not include costs associated with this HCP.

[20] The consultation history indicates that NOAA Fisheries consults on livestock grazing on Federal lands, but does not consult on similar activities on private or other non-Federal lands. The reason for this is that grazing on non-Federal lands rarely needs a Federal permit, and thus does not have a Federal nexus.

[21] This strategy was intended to be in place only for 18-months, beginning in February of 1995, but continues to be implemented.

and wildlife restoration. Standards and guidelines under PACFISH are nearly identical to those in the NWFP.

D 4.3 Cost Assessment

D 4.3.1 Federal land management activities (excluding grazing)

This analysis first classifies the (non-grazing) activities typically conducted by Federal agencies or permittees on Federal lands into ten categories using Schedule of Proposed Actions (SOPAs) and past programmatic consultations. It then characterizes "typical" project modifications by examining the Reasonable and Prudent Measures and Terms and Conditions from past salmon and O. mykiss biological opinions on these ten activities. Finally, this analysis estimates costs of each identified project modification for each of the ten activities.

Data sources of cost information for Federal lands management activities include more than 20 approved project proposals for Bonneville Power Administration's Fish and Wildlife Grants Program and the Wyden Amendment Watershed Restoration program as well as transportation costs from the State of Washington. Table D-9 presents a list of the typical project modifications characterized for each activity, and a range of costs associated with each category of Federal land management activity. Generally, where multiple cost values were available for a single project modification, a low and a high cost are estimated to provide a range of potential costs for each modification. A composite low and high range for each activity was developed using the sum of the ranges for each type of modification

To account for regional variation in the modification costs for Federal land management activities, this analysis classifies all National Forests and BLM districts into five regions based on geography: Idaho, Western Oregon and Washington, Eastern Oregon and Washington, Southern California, and Northern California. These classifications are summarized in Table D-10.

Quarterly SOPA's from National Forests were used to determine the number of each of the ten categories of projects that are occurring in each forest on an annual basis.[22] SOPA's include the same types of activities that are typically included in programmatic consultations on Pacific salmon and O. mykiss.

[22] Carol Brown, Sawtooth National Forest, March 10, 2004, suggested that the SOPA's are a good representation of typical activities that occur within forests in a "typical" year.

Table D-9 Estimated Costs of Project Modifications for Federal Land Management Activities (excluding Grazing)		
Sub-activity	**Typical Project Modifications* (per-project)**	**Project Modification Costs**
Road maintenance, aquatic habitat projects, instream work, riparian protection	- Develop an approved spill containment plan - Conduct erosion control measures - Minimize vegetation disturbance - Follow NOAA guidelines for replacement stream crossing design - Revegetate stream-side area - Gather/obtain materials needed to complete the project and implement bank stabilization - Minimize brushing in riparian areas by leaving a minimum 10 foot buffer along intermittent and ephemeral streams, and a minimum 20 foot buffer along perennial streams	$48,100 to $211,500
Recreation, site, trail, and administrative structure maintenance and associated public use	- Provide an annual monitoring report - Prevent and minimize erosion from trails	$19,400 to $30,000
Fisheries, wildlife, botany and cultural programs	- Minimize disturbance to fish by training personnel in survey method - Coordinate with other local agencies to prevent redundant surveys	$4,200 to $5,400
Pump chance/helipond maintenance and use	- Dispose of waste on stable site. - Minimize soil disturbance using filter materials such as straw bales or silt fencing - Work with engineering/fire personnel to review proposed activities to minimize potential effects to stream channel conditions and water quality - Water withdrawal with fish prevent must have a fish screen installed, operated and maintained in accordance with NMFS fish screen criteria	$12,000 to $17,600

Table D-9 Estimated Costs of Project Modifications for Federal Land Management Activities (excluding Grazing)		
Sub-activity	**Typical Project Modifications* (per-project)**	**Project Modification Costs**
Rock quarry operations/ornamental rock collecting	- Include erosion control plans for quarries to protect fish	$5,000 to $10,000
Road decommissioning, obliterating, storm-proofing and inactivation	- Develop an approved spill containment plan - Maximize activities during late summer and early fall during dry conditions - A biologist should participate in the design and implementation of the project - Dispose of waste on stable site. Nearby is acceptable if approved by a geotechnical engineer or other qualified personnel	$8,400 to $16,600
Telephone line and power line renewal	- Directionally fell hazard trees toward streams and riparian areas where it is safe and feasible to do so - Conduct erosion control measures - Minimize soil disturbance using filter materials such as straw bales or silt fencing - Rehabilitate and stabilize all disturbed areas by seeding & planting	$4,300 to $22,500
Special use permits	- Prior to issuance of a special use permit, a fisheries biologist shall make a written evaluation of the proposed action and any interrelated and interdependent effects of the action to determine if an individual consultation is necessary - Conduct erosion control measures - Minimize soil disturbance using filter materials such as straw bales or silt fencing - Rehabilitate and stabilize all disturbed areas by seeding & planting	$1,200 to $2,400

Table D-9 Estimated Costs of Project Modifications for Federal Land Management Activities (excluding Grazing)		
Sub-activity	**Typical Project Modifications* (per-project)**	**Project Modification Costs**
Timber sales	- Suspend timber hauling when road conditions become degraded - Install sediment traps along roads - Inspect and monitor roads frequently - Culverts shall be constructed to withstand 100-year floods (as in PACFISH) - No-cut riparian protection zones (RPZ) are defined and are site-specific depending on slope (but seem to follow NWFP).	$17,600
Fuel reduction, timber salvage (non-commercial), logging, thinning	- Minimize take from construction activities by ensuring that an effective spill prevention, containment and control plan is developed, implemented and maintained - Minimize take from vegetation management including salvage harvest and commercial thinning by minimizing adverse effects of key components of O. mykiss habitat - Complete annual comprehensive monitoring report	$40,300 to $115,500

Table D-10 Assessment Regions for National Forests and BLM Districts		
Region	BLM District(s)	National Forests*
Southern California	Susanville District	**Cleveland National Forest**, **Sierra National Forest**, Los Padres National Forest
Northern California	Carson City District, Ukiah District, Bakersfield District	**Six-Rivers National Forest**, **Shasta-Trinity National Forest**, Stanislaus National Forest, Toiyabe National Forest, Tahoe National Forest, Plumas National Forest, Lassen National Forest, Eldorado National Forest
Idaho	Idaho Falls District, Coeur d'Alene District	**Nez Perce National Forest, Payette National Forest, Salmon-Challis National Forest, Sawtooth National Forest**, St. Joe National Forest
Western Oregon and Washington	Coos Bay District, Eugene District, Medford District, Prineville District, Roseburg District, Salem District	**Columbia River Gorge National Forest**, **Mount Baker Snoqualmie National Forest**, **Olympic National Forest**, **Siskiyou National Forest, Siuslaw National Forest**, **Wenatchee-Okanogon National Forest, Willamette National Forest**, Rogue River National Forest, Mount Hood National Forest, Umpqua National Forest, Gifford Pinochet National Forest
Eastern Oregon and Washington	Burns District, Lakeview District, Spokane District, Vale District	**Malheur National Forest**, **Umatilla National Forest**, Ochoco National Forest, Wallowa-Whitman National Forest, Crooked River NG, Deschutes National Forest
*Bold indicates that a SOPA for this forest was used to derive estimates of activity level.		

This analysis estimates the annual total land management costs for forests that had available SOPAs by multiplying the number of annual activities of each type by the costs associated with each activity. A per-acre cost is calculated for each forest that had data available by adding together the estimated costs for each activity and dividing by that forest's total forest acres. Finally, a regional per-acre cost is estimated by averaging the per-acre costs created in the previous step for each forest within the five regions. This enabled the analysis to project costs to forests and land that did not have SOPA information available. Because BLM does not produce SOPA documents, it is assumed that BLM lands carry out the same mix of activities within a region as the USFS lands. Table D-11 lists the regional cost estimates and their ranges.

Table D-11
Estimated Regional Costs for Federal Lands Management Projects

Region	Cost Estimate (per 1,000 acres)
Idaho	$1,260 ($680 to $1,840)
Western Oregon or Western Washington	$5,900 ($3,080 to $8,710)
Eastern Oregon or Eastern Washington	$3,300 ($1,620 to $4,980)
Northern California	$8,950 ($4,910 to $12,980)
Southern California	$12,160 ($6,040 to $18,270)

This method inherently assumes that every National Forest or BLM District acre within critical habitat areas will bear a cost associated with section 7 implementation for Pacific salmon and O. mykiss. Indeed, several forests have programmatic agreements with NOAA Fisheries that compel them to place certain restrictions on activities within critical habitat areas. Even within critical habitat areas, however, it is likely that some projects will not need to be altered to accommodate salmon needs due to specific geography or specific attributes of the projects.

In addition, project modifications described in biological opinions for land management activities are included in this analysis, even if they appear to overlap baseline elements such as NWFP or PACFISH. As a result, the impact of section 7 implementation over and above the baseline elements may be overstated in areas where those baseline elements are in place. For these reasons, this analysis likely presents a high-end estimate of the costs likely to be incurred associated with Federal lands management activities.

D 4.3.2 Livestock Grazing

Project modifications for livestock grazing activities in salmon and O. mykiss habitat include fencing riparian areas, placing salt or mineral supplements to draw cattle away from rivers, total rest of

allotments when possible, and frequent monitoring. Many consultations consider impacts on salmon and O. mykiss from more than one allotment, and include general instructions to the land management agency to develop general policies (e.g., establish a utilization standard of at least 4 inches of stubble height). For cases where costs could not be allocated to a specific allotment, the total cost of the modification are applied to each allotment. This may slightly inflate estimated costs on a per-project basis.

To determine costs of section 7 implementation for Pacific salmon and ,O. mykiss associated with Federal lands grazing modifications, this analysis first characterized "typical" modifications and estimated their costs by examining Reasonable and Prudent Measures and Terms and Conditions from past salmon and O. mykiss biological opinions on grazing activities on a per-allotment basis. The number of acres was then determined for a typical grazing allotment in the areas under consideration areas using spatial data of allotments in these areas. This analysis uses the median number of acres (4,000 acres) in a sample of 4,300 allotments in Oregon, Washington, and Idaho.[23] Finally, a per-acre cost of section 7 implementation is estimated for salmon and O. mykiss for a grazing allotment by dividing the typical per-allotment cost by the number of acres in a typical allotment.

As above, this methodology assumes that each allotment will be required to comply with this full list of project modifications. This is unlikely because some grazing allotments within critical habitat may not contain primary constituent elements for salmon and O. mykiss and so their activity will not be modified as a result of section 7 implementation. In addition the NWFP and PACFISH S&Gs for grazing (GM-1 thru GM-4),[24] and the "Interagency Implementation Team (IIT) 2000 Grazing Implementation Monitoring Module" for the Malheur National Forest and other National Forest and BLM Districts in Oregon provide protections to salmon and O. mykiss from adverse effects of grazing activities. Project modifications found in biological opinions for grazing activities are included in this analysis, even if they appear to overlap baseline elements. As a result the impact of section 7 implementation over and above the baseline elements may be overstated.

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[23] This analysis uses the ICBEMP spatial data for grazing allotments for Idaho, Oregon, and Washington to determine acreage of each allotment. Allotments with unique IDs were assumed to represent unique allotments. The average acreage in this sample of allotments was 14,200. By using the median acreage, this analysis conservatively assumes a higher cost per acre for grazing modifications (Using the median: $11 to $47/acre for grazing modifications; Using the average: $3 to $13/acre).

[24] GM-1: Modify grazing practices...that retard or prevent attainment of Riparian Management Objectives or are likely to adversely affect anadromous fish. Suspend grazing if adjusting practices is not effective. GM-2: Locate new livestock handling and/or management facilities outside of RHCAs. For existing facilities, assure that facilities do not prevent attainment of Riparian Management Objectives or adversely affect listed anadromous fish. Relocate or close facilities where these objectives cannot be met. GM-3: Limit livestock trailing, bedding, watering, salting, loading, and other handling efforts to those areas and times that will not retard or prevent the attainment of RMOs or adversely affect listed anadromous fish. GM-4: Adjust wild horse and burro management to avoid impacts that prevent attainment of RMO or adversely affect listed anadromous fish.

D 4.4 Spatial and Temporal Distribution of Activity

D 4.4.1 Federal land management activities (excluding grazing)

This analyses relies on land ownership spatial data to determine USFS and BLM acreage in each watershed based on data collected from the Interior Columbia Basin Ecosystem Management Project (1995). Data include BLM Administrative Unit Boundaries and National Forest boundaries in California, Oregon, Washington and Idaho.

Cost estimates are developed from SOPAs that are available currently, and which generally have a forecast period of two years or shorter. Forest Managers report that these activities are fairly constant, however, and are likely to continue indefinitely at similar rates.[25] The annual volume of SOPA activity is therefore used as an estimate of the typical annual volume. It is also assumed that activities that take place on Federal lands are certain to bear modification costs and that these costs are borne in a single year.

D 4.4.2 Livestock Grazing

This analysis identifies grazing activity on Federal lands by intersecting spatial coverages for statewide grazing allotments with a USFS/BLM ownership coverage in the area under consideration. In the NWR, the Interior Columbia Basin Ecosystem Management Project (ICBEMP) spatial data is used for grazing. For California, grazing land ownership data was collected from the *California Digital Conservation Atlas* and used to determine the locations of future section 7 consultations.

Each acre of Federal lands grazing is assumed to be certain to bear costs of section 7 implementation at some point over the next ten years (the typical period for a grazing permit) and that the modification costs will be borne in a single year. It is assumed there is an equal probability of the consultation occurring over the ten year period.

D 4.5 Annual Expected Modification Cost Estimates

Because all costs are certain and borne in one year (by assumption) and the volume of activity per acre is annual, the regional per-acre cost estimate equals the annual expected modification cost for Federal lands management activities. For grazing, the annual expected modification cost incorporates the annual probability of a consultation (10%). These estimates are presented below in Table D-12. The use of a per-acre cost in each case means that costs at the watershed level are larger in watersheds that contain more Federal lands.

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[25] Carol Brown, Sawtooth National Forest, March 10, 2004 , suggested that projects listed in quarterly SOPAs are likely to continue indefinitely at the present annual rate

Table D-12 Estimated Annual Expected Costs for Federal Lands Management and Grazing			
Activity	**Sub-activity**	**Present Value of Costs (per-acre)**	**Annual Expected Cost (per-acre)**
Federal Land Management Activities	Idaho Federal land	$1.26	$1.26
	Western Oregon & Western Washington Federal land	$5.90	$5.90
	Eastern Oregon & Eastern Washington Federal land	$3.30	$3.30
	No. California Federal land	$8.95	$8.95
	So. California Federal land	$12.16	$12.16
Livestock Grazing on Federal Land	Grazing	$29.00	$2.90

D 4.6 Assumptions and Potential Biases

Table D-13 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-13 Federal Lands Management: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
Each acre of Federal land within critical habitat areas is assumed to be subject to section 7 implementation. In fact, many projects may not affect salmon and O. mykiss habitat.	+
Project modifications included in biological opinions for Federal land management activities are included in this analysis, even if they appear to overlap baseline elements. As a result, the impact of section 7 implement-ation over and above the baseline elements may be overstated.	+
In some cases, a consultation will cover more than one project. For cases where costs could not be allocated to a specific project (particularly for grazing projects), the analysis applied the total cost of the modification to each allotment. This may slightly inflate estimated project modification costs on a per-project basis.	+

Table D-13 Federal Lands Management: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
Land management agencies are assumed to carry out the list of land management activities consistently within geographical areas (e.g Cleveland and Sierra National Forests are assumed to conduct the same mix of activities because they fall within the Southern California region). Real variations in geography and management could result in different management activities in each management unit.	+/-
Per-project costs of modifications to specific land management activities are assumed to be uniform across geographic areas (e.g. costs of a fuels management project are assumed to be consistent across all regions).	+/-
On December 8, 2003, NOAA Fisheries and USFWS issued "Joint Counterpart Endangered Species Act Section 7 Regulations" whose purpose is "to streamline projects that fit under the National Fire Plan." These new regulations may alter the future consultation behavior of NOAA Fisheries regarding fuel reduction/fire management activities on Federal lands. If executed as planned, future informal consultations will be streamlined. As a result, estimated costs of fuel reduction activities may be overstated.	+/-
- : May result in an underestimate of real costs + : May result in an overestimate of real costs +/- : Has an unknown effect on estimates	

D 5. Transportation Projects

D 5.1 Overview

- Transportation projects that affect Pacific salmon and O. mykiss habitat are wide ranging and include road widening, bridge reconstruction, and ferry terminal restoration. Examination of the consultation history reveals that roadwork, bridgework, and culvert projects encompass nearly 90 percent of all transportation projects that have been consulted upon.

- Transportation projects can produce environmental impacts that may directly kill or injure salmon and O. mykiss, or may disturb habitat. The impacts can be direct (i.e., riparian destruction during a bridge replacement) or more ancillary (i.e., storm water run-off disturbance following a road widening).

- The method for estimating section 7 impacts on transportation projects is to measure the direct costs associated with section 7 implementation. First, a review of the relevant consultation history was undertaken and spatial data was used to identify the types and sizes of transportation projects planned to occur. The spatial data was then combined with typical project modification costs (fixed and variable) to estimate a cost for each project type and a total cost for transportation activities in each watershed.

- Secondary economic impacts resulting from changes to regional transportation mobility as a result of Section 7 implementation are expected to be minor. The consultation record indicates that transportation agencies can comply with section 7 project modifications without precluding any projects within critical habitat.

- On a per-project basis, project modification costs associated with transportation activities are small relative to other activity types. Because of the large volume of these projects, however, they may prove significant in specific geographical regions. These costs are likely to be borne or passed on to the Federal government, which accordingly will ultimately bear the majority of the costs.

D 5.2 Background

Nearly a quarter of all Section 7 consultations conducted by NOAA Fisheries during 2001-2003 involved transportation projects. These projects may entail the widening of a road, the reconstruction of a bridge, or the restoration of a ferry terminal. The Federal nexus for a transportation project may be through permitting or funding provided by the Army Corps of Engineers (USACE), Federal Highways Administration (FHWA) and/or the Federal Aviation Administration (FAA). The USACE permits bridgework, roadwork, and railroad restoration projects that need Clean Water Act permits. FHWA funds bridgework, roadwork, railroad restoration projects, and ferry terminal maintenance, and the FAA permits aircraft/airport repair and maintenance.

The California Department of Transportation (Caltrans) has been engaged in an ongoing bridge retrofit program since the early 1970's. The 12,000+ bridges in the California Highway System, plus an additional 11,500 city and county bridges are inspected on a biennial basis. A major component of this program is the San Francisco-Oakland Bay Bridge East Span Seismic Safety Project (SFOBB), a major construction endeavor to upgrade the East Span section of the Bay Bridge to make it less susceptible to damage in an earthquake. Though details of the planned upgrade have not been finalized, the project is anticipated to have major economic and environmental implications and may result in a consultation with NOAA Fisheries.

Transportation projects can produce environmental impacts that may directly jeopardize the existence of salmon and O. mykiss, or may disturb habitat. The impacts can be direct (for example, riparian destruction during a bridge replacement) or more ancillary (for example, storm water run-off

disturbance following a road widening). Federal agencies involved in transportation projects are required by NOAA Fisheries to modify their activities to avoid both direct and indirect take of salmon. Table D-14 lists both the effects from and the modifications typically required of transportation projects.

Table D-14
Typical Project Modifications for Transportation Projects

Project Types	Effect on Salmon	Typical Project Modifications
Roadwork, Bridgework, Culvert Projects	- In-water work during critical salmon life stages that may disturb spawning and development ability - Pollution of chemicals/waste into stream water by construction/repair machinery - Direct handling of salmon during transportation activities (i.e culvert installation) - Discharge of construction water - Stormwater run-off disturbance to habitat - Stream bank damage during construction activities (erosion and pollution)	- Limit time of in-water work to avoid take during vulnerable salmon life stages - Ensure isolation of in-water work area and proper fish handling methods - Develop effective erosion and pollution control measures - Stormwater management measures - Restoration of construction site through contouring, mulching, seeding and planting with native vegetation - Monitoring and evaluation both during and following construction
Other Transportation Projects	- Sound disturbance to salmon habitat due to piling installation - In-water work during critical salmon life stages that may disturb spawning and development ability - Pollution of chemicals/waste into stream water by construction/repair machinery	- Use of bubble curtain to maintain low sounds during ferry restoration - Obtaining hydraulic permit approval from State. - Monitoring and evaluation both during and following railroad restoration project - Construction time limits - Captive breeding, re-establishment and habitat restoration program

Examination of the consultation history reveals that roadwork, bridgework, and culvert projects encompass nearly 90 percent of all transportation projects that have been the subject of a consultation, and so are the categories on which this analysis focuses.

D 5.3 Cost Assessment

To determine the costs of section 7 implementation for Pacific salmon and ,O. mykiss associated with transportation projects, spatial data and recent consultation history were examined to identify the typical characteristics of transportation projects in the areas under consideration. Typical project modifications were then defined by examining Reasonable and Prudent Measures and Terms and Conditions from past salmon and O. mykiss biological opinions on transportation projects. Costs of each identified project modification were estimated accordingly. Some costs vary continuously with project scale (usually measured by miles of roadway or feet of stream affected), and so costs were categorized as either fixed or variable depending on the nature of the modification. Data sources for cost information for transportation projects include the *Integrated Streambank Protection Guidelines* (Washington Department of Transportation), published economic analyses, and various other cost studies. Table D-15 lists the estimated costs associated with typical project modifications identified for road, bridge and culvert projects.

Modification costs classified as fixed are incurred once in the course of a project, and do not vary continuously with project scale (e.g. costs of spill prevention plan development, costs of water quality monitoring). A low, medium and high cost level for each fixed project modification cost is presented in Table D-15, to provide a range of potential costs for each modification.

In contrast to fixed costs, some costs are highly dependent on the scale of a transportation project and can be calculated on that basis. These variable costs may include restoration efforts, bank stabilization, and emergency erosion control, and are a function of the length of the waterway affected by the project (or for which mitigation efforts are required). Because data are more widely available for project length than for stream length impacted, the relation between the two using data on both from biological opinions was contemplated. Unfortunately, instances where data on both road length and stream length impacted are available are rare, and so two cases were used to develop the following relationship:

$$\textit{Stream Length Impacted (SLI) (ft)} = 100 + 5 \times \textit{Road Length (miles)}$$

Using this relation, the variable cost for a project that impacts N feet of stream would be

$$\textit{Total variable cost} = N \times \textit{modification cost estimate (per-foot)}$$

The estimated total modification cost is then the sum of the fixed cost for the project's particular scale and the variable costs as computed above.[26]

[26] In this case, the high end of the variable cost range is used as the representative cost estimate. Although the review of the data sources found projects with variable costs at the lower end of the range, the higher end is applicable in instances that are far more typical. This was not the case for other activities where a range of costs was determined.

Table D-15
Estimated Costs of Project Modifications for Transportation Projects

Project Modifications	Fixed Costs (per-project)*			Variable Costs (per linear foot of stream impacted)
	Low	Medium	High	
Pre-construction Surveys	$4,900	$5,950	$7,000	N/A
Develop and implement a site-specific spill prevention, containment and control plan and remove toxicants as they are released	$5,000	$7,500	$10,000	N/A
Water quality monitoring	$5,000	$17,500	$30,000	N/A
Excavation and relocation of materials during a project where they cannot enter wetlands.	$1,000	$3,000	$5,000	N/A
Bank stabilization	N/A	N/A	N/A	$25.00-65.00
Maintain supply of emergency erosion control materials (slit fence and straw bales)	N/A	N/A	N/A	$2.50-$5.50
Use of boulders, rock, woody materials from outside of the riparian area.	$500	$2,750	$5,000	N/A
Stormwater management measures	$2,000	$2,650	$3,300	N/A
Restoration of construction site through contouring, mulching, seeding and planting with native vegetation	N/A	N/A	N/A	$10-$60
Monitoring and evaluation both during and following construction	$4,400	$7,700	11,000	N/A
Construction and implementation of coffer dam (a temporary structure to exclude water during instream work)**	$4,000	$6,000	$8,000	N/A
Ensure isolation of in-water work area and proper fish handling methods (hoop net sampling, electro-fishing)**	$1,000	$2,500	$5,000	N/A
TOTALS	**$27,800**	**$55,550**	**$84,300**	**$37.50-$130.50**

*Scale classes for fixed costs: Low = <1 mile, Medium = 1-10 miles, High = >10 miles
**These project modifications only apply to bridge and road projects

D 5.4 Spatial and Temporal Distribution of Activity

California, Idaho, Washington, and Oregon have produced future transportation plans, which were used to forecast the locations of transportation projects. These plans include spatial information, budget allocation, and road mileage for projected road, bridge, culvert, and transit activities in each state. The plans vary in scope as well as time frame, and thus, the nature of the data varies considerably across regions. Table D-16 summarizes all projected, federally funded transportation projects within the critical habitat designation. Because exact start and completion dates are often difficult to anticipate, this analysis assumes that the projects included in the state transportation plans represent an estimation of the number and types of projects that are completed within a given 5 year period.

Table D-16
Summary of Transportation Projects Affected by Critical Habitat

State	Data Source	Time Frame for Planned Projects (years)*	Total Number of Projects within Areas under Consideration
Oregon	OR State Improvement Plans (STIP) 2002-2005	3	198
Idaho	ID State Improvement Plans (STIP) 2002- 2005	3	28
California	California Transportation Investment System (CTIS)	5	543
Washington	WA 6-Year Capital Improvements Plan	6	379

*Although transportation plans differ in time frame, this analysis assumes that all projects listed in each state's transportation plan are completed within 5 years

D 5.5 Annual Expected Modification Cost Estimates

Using the data in the state transportation plans, the above formula was applied to each project in the plan. All modification costs are assumed to be certain and borne in one year, and the probability of a project bearing these costs is uniform through the 5 year period for transportation projects. As a result, the annual expected modification cost for a project is equal to the estimated project cost derived from the formula above multiplied by the probability of occurrence (0.20). Because projects vary in road mileage, the estimated project costs vary as well. Table D-17 summarizes estimated and annual expected costs for a project that involves the average mileage (3.2 miles).

Table D-17 Estimated Annual Expected Per-Project Costs for Transportation Projects			
Activity	**Sub-activity**	**Present Value of Costs**	**Annual Expected Cost**
Transportation*	Bridges & culverts (small)	$41,778	$8,356
	Bridges & culverts (medium)	$69,478	$13,896
	Bridges & culverts (large)	$98,278	$19,656
	Roads (small)	$36,778	$7,356
	Roads (medium)	$60,978	$12,196
	Roads (large)	$85,278	$17,056
*Transportation costs are presented for a project of average mileage (3.2 miles).			

D 5.6 Assumptions and Potential Biases

Table D-18 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-18 Transportation Projects: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
This analysis assumes that all project modifications included in section 7 consultations for transportation projects are implemented specifically for salmon and O. mykiss protection and are not part of the baseline (e.g., these measures would not already be conducted as part of Best Management Practices).	+
Best Management Practices are followed strictly as outlined in state legislation, and do not overlap with recommended project modifications.	+/-
Future methods of compliance with specific project modifications will mirror past methods (i.e., pollution/erosion control plans do not change significantly over time).	+/-
All streams containing salmon and O. mykiss in the area under consideration are assumed to have similar ecological sensitivity with regards to pollution and chemical contamination.	+/-

Table D-18 Transportation Projects: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
Transportation projects may include sub-projects within them (e.g., road projects w/ bank stabilization efforts). If sub-projects are constructed as part of a transportation project, project modification costs could be understated. Available data do not enable a reasonable forecast projects that would include sub-projects, however.	-
Long-term effects of modifying transportation projects in critical habitat areas on regional transportation functions (such as congestion and air pollution) are not included in this analysis. If projects occur that are not included in state transportation plans, this analysis may understate costs.	-
State transportation plans are assumed to include all major federally-funded transportation projects planned to occur over the designated the time period.	-
- : May result in an underestimate of real costs + : May result in an overestimate of real costs +/- : Has an unknown effect on estimates	

D 6. Utility Line Projects

D 6.1 Overview

- The analysis separates the category of "utility lines" into two subcategories: pipelines and outfall structures. Overall, utility lines account for approximately two percent of the total consultation activity for the salmon in the consultation record. Most of these consultations are associated with pipeline projects.

- The most common Federal agencies involved in consultations regarding utility lines are the USACE, and FERC. USACE consults with NOAA Fisheries regarding permits issued Section 404 of the Clean Water Act and/or Section 10 of the River and Harbors Act. FERC consults on pipeline projects that have the potential to affect threatened and endangered species and their habitat.[27] For projects that may impact wetlands or cross water bodies, FERC maintains a list of construction and mitigation procedures. These mitigation procedures include the use of directional drilling, rather than open cut construction, and suggest

[27] Personal communication with Robert Arvedlund, Federal Energy Regulatory Commission, February 25, 2003

mitigation activities during the proposal stage.[28] Therefore, some of the project modification costs estimated to be attributable to salmon critical habitat may be overestimated as these measures may be already required.

- Per-project costs of section 7 implementation on pipeline and outfall structure projects are estimated to be $101,000 ($100,000 to $102,000), using historical project modification costs.

D 6.2 Background

Activities classified as utility lines projects include the installation or repair of pipes or pipelines utilized in gas or liquids; cables, lines or wires used to transmit electricity or communication; and outfall structures of utilities such as waste water treatment plants or powerplants. These activities can impact salmon and O. mykiss habitat through actions such as excavation, temporary sidecasting of excavated materials, backfilling of the trench, and restoration of the work site to pre-construction contours and vegetation.

Table D-19 describes the common project modifications recommended by NOAA Fisheries for each type of utility line activity based on a review of the consultation history. These descriptions illustrate how projects may be impacted by section 7 implementation.

Table D-19
Typical Project Modifications for Utility Line Projects

Sub-activity	Typical Project Modifications
Pipeline Projects	- Use directional drilling - No change in the pre-construction contours - Stockpile soil from the excavation and replace in trench - Minimize roads and other encroachments to the maximum extent possible - Return banklines to original slopes and revegetated with native vegetation - Document location and design of the project - Erosion control

[28] *Wetland and Waterbody Construction and Mitigation Procedures.* Federal Energy Regulation Commission. January 17, 2003.

Table D-19 Typical Project Modifications for Utility Line Projects	
Sub-activity	**Typical Project Modifications**
Outfall Structure Projects	- Construction access via a barge from the waterway - Trench excavation restrictions - Effluent restrictions - Backfill trench with clean sand - Flag boundaries - Complete site restoration and cleanup - Pollution and erosion control plan - In water work period restrictions - All blasting occurs in the dewatered area of the coffer dams - Provide fish salvage and/or fish passage - Stormwater management - Isolate in-water work area
Sources: National Oceanic and Atmospheric Administration. Biological Opinion of Corps of Engineers' Programmatic Consultation for Permit Issuance for 15 Categories of Activities in Oregon, March 21, 2001. OSB2001-0016; National Oceanic and Atmospheric Administration. Biological Opinion for the Port Of St. Helens Industrial Outfall and Portland General Electric Power Plant, Port Westward Industrial Park, Columbia River, Columbia County, Oregon, August 1, 2003. 2002/00013. National Oceanic and Atmospheric Administration. Biological Opinion of Corps for Miller Creek Wastewater Treatment Plant Outfall Replacement, WRIA 9, August 15, 2003, 2002/00355. National Oceanic and Atmospheric Administration. Biological Opinion for the Myrtle Creek and Tri-City Sanitary District Wastewater Treatment Plant Improvement, South Umpqua River, Douglas County, Oregon, April 30, 2003, 2002/00376.	

D 6.3 Cost Assessment

Data was used from local municipalities that have experience with utility line project modifications through consultations with NOAA Fisheries and the USACE to estimate modification costs. Table D-20 lists the typical project modifications associated with each sub-activity and presents a range of costs associated with the corresponding modifications. This analysis assumes that the costs are certain and will be borne in a single year.

Using the available data, it is not possible to distinguish between types of utility projects (pipeline projects *v.* outfall structure projects). As a result, projects were assigned an equal probability of involving the two types of sub-activities and their estimated modifications costs ($102,000, the midpoint of the range for pipeline projects, and $100,00 for outfall structure projects). The annual

expected modification cost for a project is then equal to the midpoint of these two figures, or $101,000 per-project.

Table D-20
Estimated Per-Project Costs of Project Modifications for Utility Line Projects

Sub-activity	Typical Project Modifications	Estimated Costs
Pipeline Projects	- Erosion control (rock lining) - Bypass stream corridor - Riparian planning - Directional drilling ($800 to $1,000 per foot)	$5,000 to $199,000
Outfall Structure Projects	- Flag boundaries - Complete site restoration and clean up - Pollution and erosion control plan - Timing restrictions - Construction monitoring by an on-site biologist - Store and replace native soil upon project completion - Implement construction techniques to avoid sedimentation and conduct a sediment survey.	$100,000

D 6.4 Spatial and Temporal Distribution of Activity

The location of utility line projects was identified using data on the latitude and longitude of historic USACE permits on utility lines. This analysis assumes that the historic patterns of these permits are likely to predict the general location of potential future projects, which will then engage in consultations.[29] It is further assumed that the annual volume and locations of USACE permits for utility lines are representative of the annual volume and locations of projects that need to be modified to comply with section 7 for salmon and O. mykiss.

Limitations are associated with using historic data to predict future permitted projects. The main concern is that past location is not a good predictor of future location. Although historic consultations are not a perfect indicator of future consultations, areas of concentrated activity in the

[29] Future consultations may also cover pipeline projects permitted by FERC. This analysis therefore maps pipeline right-of-ways in each watershed. Modification costs were not estimated for these right-of-way projects, however, as it was not possible to estimate the likelihood that a future pipeline project will in fact utilize a current right-of-way, and will also be involved in a consultation for salmon and O. mykiss. This analysis is therefore limited to known pipeline and outfall structures.

past are likely to be areas of concentrated activity in the future and therefore this method produces a reasonable geographic distribution of activity given available data.

D 6.5 Annual Expected Modification Cost Estimates

Given the assumptions that all modification costs are certain and borne in one year, and that the annual volume and locations of USACE permits for utility lines are representative of the annual volume and locations of projects that need to be modified to comply with section 7 for salmon and O. mykiss, the annual expected modifications costs are equal to the estimated modifications costs, as shown in Table 21.[30]

Table D-21
Estimated Annual Expected Per-Project Costs for Utility Line Projects

Activity	Sub-activity	Present Value of Costs	Annual Expected Cost
Utility Lines	Outfall structures and pipelines	$101,000	$12,625

D 6.6 Assumptions and Potential Biases

Table D-22 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-22
Utility Line Projects: Assumptions and Potential Biases

Assumption	Direction of Potential Bias
Historic location of USACE permits for utilities and location of right-of-ways are the most reasonable predictors of future locations available.	+/-
Costs associated with implementing past consultations are the most reasonable predictor of future costs.	+/-
Project modification recommendations do not overlap with Federal, state, or local laws.	+

[30] USACE permit data from different districts is adjusted to account for temporal differences in the data. For example, the data set from the Seattle USACE district covered 4 years, while the data set from the Sacramento district covered 8 years. The annual volume of projects requiring modifications is estimated by dividing the volume obtained from each district's data by the number of years covered by that district's data set.

Table D-22 Utility Line Projects: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
Because there is no way to differentiate between pipelines with FERC and USACE nexuses, half of all pipelines are assigned directional drilling costs.	+/-
Section 7 consultation will not result in any net reduction in utility transmission capability. The same amount of utility lines will be constructed, although potentially at a higher cost and/or in a different location.	+/-
+ : This assumption is likely to bias results upward. - : This assumption is likely to bias results downward. +/- : This assumption could bias results upward or downward.	

D 7. Instream Activities (including Dredging)

D 7.1 Overview

- The analysis assesses impacts on instream activities that are likely to result from section 7 implementation within critical habitat. Instream activities account for approximately 16 percent of the total consultation activity for the salmon in the consultation record. The majority of dredging consultations are encompassed by programmatic consultation with NOAA Fisheries. Some instream projects are addressed in an independent consultation but many are part of larger projects (e.g., pile driving may also be associated with large bridge projects, or an airport expansion has the potential to include dredging).[31]

- Actions associated with instream activities that may affect salmon and O. mykiss include dredging, construction or repair of breakwaters, docks, piers, pilings, bulkheads, boat ramp, and docks. For the purpose of the analysis, instream activities are divided into the following sub-activities: boat dock and boat ramp projects; bank stabilization projects; breakwaters and bulkhead projects; and dredging.

- Consultations on boat dock, boat launch, and bank stabilization projects typically involve USACE permits. Modification to these projects required to comply with

[31] Personal communication with Wes Silverthorne, Economist Santa Rosa Field Office, California, NOAA personnel, January 9, 2004.

section 7 for salmon and O. mykiss include shoreline planting, construction materials restrictions, use of bubble curtains, habitat improvement, spill prevention contaminant control plan, erosion control, and timing restrictions.

- Consultations on dredging projects typically involve a USACE permit. Modifications to dredging include work window constraints, extension of the prescribed work window, additional survey work, and mobilization costs.

- In the San Francisco Bay dredging is regulated by a Long-Term Management Strategy (LTMS) For the Placement of Dredged Material in the San Francisco Bay Region. The LTMS gives dredging windows, disposal sites, and targets for distribution of dumping among sites. NOAA Fisheries treats these permit applications programmatically unless projects cannot occur within the dredging windows and a formal consultation is required. Based on historical project experience, this is expected to occur 14 percent of the time. Because work windows and disposal sites are required by the LTMS these potential project modifications are considered baseline. Therefore, it is assumed that mobilization costs are the only costs attributable to section 7 implementation.

D 7.2 Background

Instream activities include two broad types of projects: construction, maintenance, repair, or other work that is conducted instream, and dredging. Actions associated with the first type may involve structure removal, excavation, filling, and driving pilings. Most of the consultations on this type of project are associated with dock, pier, and breakwater projects.

Instream activity can affect salmon and O. mykiss in a number of ways. Turbidity associated with instream activities may interfere with salmon and O. mykiss visual foraging, increase susceptibility for predation, and interfere with migratory behavior. Chemicals and waste materials including toxic organic and inorganic chemicals that accumulate in sediment may be directly toxic to aquatic life or a source of contaminants for bioaccumulation in the food chain. The release of ammonia, a common by-product produced in anaerobic sediments, may affect aquatic species as it is re-suspended in the water column. Instream activity may adversely affect invertebrate colonies, which may result in some loss of salmon and O. mykiss prey. For dredging, entrainment can occur when the fish are unable to overcome the water velocities near the draghead and are pulled into the hold of the ship during dredging activities.

Table D-23 describes the common project modifications recommended by NOAA Fisheries for each type of instream sub-activity based on a review of the consultation history. These descriptions illustrate how projects may be modified by section 7 implementation.

Table D-23 Typical Project Modifications for Instream Activities (including Dredging)	
Sub-activity	**Typical Project Modifications**
Boat Dock	- Date restrictions - Temporary silt fences and floating silt barriers to limit sediment entry into river and reduce turbidity effects - Disposal of excavated material at upland disposal site - Assurance of clean, inert material making contact with water - Maintenance of all heavy equipment to insure cleanliness and devoid of external oil, fuel or other pollutants - Strict following of permit and contract requirements - Use of bubble curtain to minimize effects of sound waves from pile driving on listed fish - Minimize creation of predator habitat by minimizing incidental take from heavy equipment use - Minimization of incidental take from use of heavy equipment that may disturb riparian and aquatic systems - Minimization of incidental take from erosion control activities by using best available technology - Removal of one piling and its associated dock
Boat Launch	- Date restrictions - Insure isolation from flowing water to minimize take - Development and implementation of erosion and pollution control measures through area of disturbance - Implementation of measures to minmize impacts to riparian and instream habitat - Implementation of measures to treat water and limit fill within the 100-year floodplain - Ensure temporary/permanent impacts to riparian instream habitat are restored and mitigated

Table D-23 Typical Project Modifications for Instream Activities (including Dredging)	
Sub-activity	**Typical Project Modifications**
Bank Stabilization	- Limit the extent of rock placement in the channel - Spill Prevention Contaminant Control Plan - Erosion Control - Submit a monitoring and evaluation to USACE and NMFS - Replant disturbed areas with native plants with 80 percent survival after three years - Ensure that the in-water work activities (toe trench excavation and scour protection placement) are isolated from flowing water - Use fish screens on all water intakes - Fisheries biologist oversee capture and release program - Move excavated materials to upland areas - Restore all damaged areas to pre-work conditions - Install fencing as necessary to protect revegetated sites
Breakwater	- Minimize incidental take from general construction by excluding authorized permit actions and applying permit conditions - Comprehensive monitoring and reporting program to make sure objectives are met - Equipment will be fueled and lubricated in designated refueling areas at least 150 feet away from stream
Bulkhead	- In-water work restrictions - Fish passage - Removal of treated wood - Restricted use of heavy equipment - Isolation of in-water work area - Compensatory mitigation - Water intake screening - Pollution/erosion control - Capture and release - Conservation of native materials - Earthwork

Table D-23 Typical Project Modifications for Instream Activities (including Dredging)	
Sub-activity	**Typical Project Modifications**
Bulkhead, cont.	- Site restoration - Date restrictions - Minimize disturbance to riparian habitat - Minimize disturbance due to construction barges - Minimized contamination of riverine habitat - Monitoring
Dredging	- Work windows - Dredge-material disposal requirements
San Francisco Bay Dredging	- Dredging windows - Disposal sites - Targets for distribution of dumping among sites
Sources: National Oceanic and Atmospheric Administration. Biological Opinion for Construction of a new boat dock at Columbia Cove Park, Okanogan County, Washington, May 16, 2003. 2001/01013; National Oceanic and Atmospheric Administration. Biological Opinion for Rouge River (Depot Street) Bridge Replacement Project, Jackson County, Oregon, October 23, 2003. 2002/00816; National Oceanic and Atmospheric Administration. Biological Opinion for McCormick Pier Repair Project, Willamette River Mile 11.3, Multnomah County, Oregon, May 23, 2003. 2002/01399; National Oceanic and Atmospheric Administration. Biological Opinion for the Georgia-Pacific Bulkhead Replacement Project, Yaquina River Basin, Lincoln County, Oregon, February 21, 2003. 2002/01314; Personal communication with Peter Losavita, U.S. Army Corps of Engineers, San Francisco District, personnel, December 4, 2003.	

D 7.3 Cost Assessment

This analysis employs data from local municipalities that have experience with instream project modifications through consultations with NOAA Fisheries and the USACE to estimate modification costs. Due to data limitations, costs are not separately estimated for bulkhead and breakwater projects, but it is assume they are included as part of other sub-activity projects. Table D-24 lists the different sub-activities with the typical project modifications and cost estimates.

Table D-24
Estimated Per-Project Costs of Modifications for Instream Activities (including Dredging)

Sub-activity	Typical Project Modifications	Estimated Costs
Boat Dock	- Shore line planting. - Paint pilings white. - Bubble curtain. - Planks and floats graded for 60 percent light passage.	$25,000
Boat Launch	- Habitat improvements, including native plant installation and replacement of failed plantings - Redesign dock to meet NOAA Fisheries performance standards. - Professional fish biologist to monitor construction.	$28,400
Bank Stabilization	- Spill Prevention Contaminant Control Plan - Erosion Control - Monitoring and evaluation - Replant disturbed areas with native plants with 80 percent survival after three years - Ensure that the in-water work activities are isolated from flowing water - Fisheries biologist oversee capture and release program - Move excavated materials to upland areas - Restore all damaged areas to pre-work conditions - Install fencing as necessary to protect revegetated sites	$34,050 to $84,000
Dredging Projects	- Work window constraint - Extension of the prescribed work window[1] - additional survey work if safety is an issue - Mobilization cost[2] (occurs 14 percent of the time)	$332,000 to $1,310,000[3]
San Francisco Bay Dredging	- Dredging windows - Disposal sites - Targets for distribution of dumping among sites	$42,000 to $140,000

[1]Requires between 40 and 120 man-hours.
[2] If a work window extension is not granted, USACE must complete the project during the next work window. Restarting the project results in additional mobilization costs. Mobilization costs are approximately one third of total project costs.
[3] Personal communication with Michael Dillabaugh, U.S. Army Corps of Engineers, San Francisco District, Operations and Readiness Division, Project Manager, November 24, 2003.

Because of limitations in the spatial data, the first three sub-activities are combined – boat dock construction, boat launch construction, and bank stabilization projects – into one sub-activity. The midpoint of the associated range of costs is used as the expected cost estimate for each sub-activity: $54,500 ($25,000 - $84,000) for the combined instream project sub-activity, and $821,000 ($332,000 - $1,310,000) for dredging. Costs are expected to be borne in a single year.

D 7.4 Spatial and Temporal Distribution of Activity

The best data currently available to predict the location of future instream activities is the latitude and longitude location of historic USACE permits. This analysis assumes that historic patterns of instream projects are likely to predict the general location of potential future projects over the next eight years (the longest period in the USACE data). The annual volume and locations of USACE permits for instream activities and dredging projects are further assumed to be representative of the annual volume and locations of projects that need to be modified to comply with section 7 for salmon and O. mykiss.

Limitations exist associated with using historic data to predict future permitted projects. The main concern is that past location is not a good predictor of future location. Although historic consultations are not a perfect indicator of future consultations, areas of concentrated activity in the past are likely to be areas of concentrated activity in the future and therefore this method produces a reasonable geographic distribution of activity given available data.

D 7.5 Annual Expected Modification Cost Estimates

As noted above, all modification costs are assumed to occur for each project to be borne in one year, and the annual volume and locations of USACE permits for instream activities and dredging projects are assumed to be representative of the annual volume and locations of projects that need to be modified to comply with section 7 for salmon and O. mykiss.[32] These assumptions produce the annual expected modification costs for instream projects and dredging shown in Table D-25.

Table D-25
Estimated Annual Expected Per-Project Costs for Instream Activity Projects

Activity	Sub-activity	Present Value of Costs	Annual Expected Cost
Instream Activities	Boat dock, boat ramps, bank stabilization	$54,500	$54,500
Dredging	Dredging	$821,000	$821,000

[32] USACE permit data from different districts is adjusted to account for temporal differences in the data. For example, the data set from the Seattle USACE district covered 4 years, while the data set from the Sacramento district covered 8 years. The annual volume of projects requiring modifications is estimated by dividing the volume obtained from each district's data by the number of years covered by that district's data set.

D 7.6 Assumptions and Potential Biases

Table D-26 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-26
Instream Activities and Dredging: Assumptions and Potential Biases

Assumption	Direction of Potential Bias
Historic location of USACE permits for instream activities including dredging are the most reasonable predictors of future locations available.	+/-
Costs associated with implementing past consultations are the most reasonable predictor of future costs.	+/-
Project modification recommendations do not overlap with Federal, state, or local laws or best management practices.	+
Range of costs for case studies are representative of all instream activities.	+/-

- : May result in an underestimate of real costs
+ : May result in an overestimate of real costs
+/- : Has an unknown effect on estimates

D 8. National Pollutant Discharge Elimination System Permitted Facilities

D 8.1 Overview

- This analysis examines the potential economic impact to facilities that are required to obtain National Pollutant Discharge Elimination System (NPDES) permits. The EPA and NOAA Fisheries recently authored guidance to States and tribes on the development of temperature criteria deemed protective of salmon and O. mykiss. As a result, NPDES-permitted facilities in the Pacific Northwest are required to ensure effluent discharge does not raise the temperature in receiving waters above site-specific minimum temperature standards.[33] Facilities employ a range of temperature control strategies to meet these standards.

[33] U. S. Environmental Protection Agency, EPA Region 10 Guidance For Pacific Northwest State and Tribal Temperature Water Quality Standards, EPA 910-B-03-002, April 2003.

- The nexus for this activity is EPA's approval of State Water Quality Standards. NOAA Fisheries has consulted with EPA regarding the review and approval of the temperature component of water quality standards. Although a nexus does not apply directly to each NPDES-permitted facility (due to EPA's delegation of permitting to state water quality agencies), this analysis includes the project modifications and costs resulting from future compliance with the new standards by NPDES-permitted facilities.[34]

- To comply with the temperature criteria, NPDES-permitted facilities identify and employ a host of temperature control procedures through Temperature Management Plans (TMPs). Controls include process optimization, pollution prevention, land application, and cooling towers.

- The analysis estimates the operations and maintenance (O&M) costs and capital expenditures necessary to comply with the temperature criteria. These compliance costs are based on a sample of major and minor NPDES-permitted facilities considered in EPA's Economic Analysis of the Proposed Water Quality Standards Rule for the State of Oregon.[35] The estimated modifications costs are $630,467 ($476-483 - $784,451) for a major facility and $72,039 ($0 - $144,078) for a minor facility.

- Impacts of section 7 implementation resulting from NOAA's consultation on the temperature criteria will vary depending on a facility's compliance with existing temperature standards, and whether it is subject to these requirements at all. To reflect this uncertainty, this analysis assumes that any major NPDES-permitted facility has a 25 percent probability of requiring compliance-related expenditures, and any minor NPDES-permitted facility has a 20 percent chance of incurring related costs.

D 8.2 Background

NOAA Fisheries has consulted with EPA on various aspects of its approval of State Water Quality Standards. Since the species were listed, 14 informal and one formal consultation have been completed, including development of Total Maximum Daily Loads (TMDLs), review of non-temperature related Water Quality Standards, clean up of Superfund sites, and review of pesticide applications. With the exception of pesticide applications, the majority of these activities do not

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[34] Although California was not part of the Northwest Temperature Guidance Consultation, this analysis assumes that similar requirements to protect salmon in that state will lead to similar economic impacts in the future.

[35] Science Applications International Cooperation: *Economic Analysis of the Proposed Water Quality Standards Rule for the State of Oregon* . Science Applications International Corporation. Reston, VA. 2003. EPA No. 68-C-99-252.

represent a significant portion of the consultation record nor are they expected to increase in the future.[36]

In general, the only incremental standard that has been affected explicitly by concern for salmon and O. mykiss involves water temperature controls. While NPDES-permitted facilities have always been required to adhere to certain temperature criteria associated with effluent discharge, the 2003 guidance has led to stricter standards where salmon and O. mykiss are known to spawn or rear. As a result, this analysis focuses on costs associated with the temperature criteria.

D 8.3 Cost Assessment

This analysis applies EPA's economic impact assessment to estimate modifications costs for NPDES-permitted facilities. The EPA analysis provides cost estimates to meet the spawning and rearing temperature criteria of 18 degrees Celsius for salmon and O. mykiss rearing, 16 degrees Celsius for core juvenile rearing, and 13 degrees Celsius for spawning. Temperature control procedures commonly employed at NPDES-permitted facilities include:

- Process optimization (identifying management procedures that could be altered to reduce thermal loads to waste streams);
- Reduced volume of discharge by reusing effluent;
- Storing heated wastewater;
- Off stream cooling/evaporation ponds; and
- Istalling treatment technology to reduce temperatures.

The EPA analysis assumes that facilities first employ low cost controls and then consider more costly controls, if necessary.

Based on EPA's sample of facilities, capital costs are assumed to be incurred in the first year, and operations and maintenance (O&M) costs are incurred uniformly over a 20 year period. Facilities were then divided into two categories, also based on the EPA study. Major facilities are those that may require significant capital expenses to comply with the temperature criteria, while minor facilities need only incur O&M expenditures.

Table D-27 provides a summary of the cost estimates and their ranges, based on the EPA analysis.

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[36] As a result of recent legal proceedings *(Washington Toxics Coalition, et al., v. EPA*), the EPA may have to consult more actively with NOAA Fisheries on pesticide applications. This analysis does not analyze this sub-activity due to uncertainty regarding the outcome of this case. Although a means of spatially identifying where such constraints may occur, or estimating the related incremental costs, is not identified, this sub-activity will be included in the final economic analysis if necessary. Based on NOAA Fisheries past consultation with the United States Forest Service (USFS) and the Bureau of Land Management (BLM), modifications associated with the *ground and aerial application* (not *review* of use permits) generally call for buffer zones around streams or other constraints.

D 8.4 Spatial and Temporal Distribution of Activity

This analysis identifies the location and type (major or minor) of facilities potentially affected by the temperature requirements using latitude and longitude data from the Washington Department of Ecology, the Oregon Department of Environmental Quality, EPA Region 10, and EPA Region EPA Region 9. The data represent the location of facilities as of 2003 or 2004. This analysis assumes that if a facility is required to comply with the temperature criteria, it will do so immediately.

Table D-27
Estimated Per-Project Costs of Modifications for NPDES-permitted Facilities

Facility Type	O & M	Capital Cost	Present Value of Cost
Minor	$6,800 ($0 - $13,600)	$0	$72,039
Major	$19,725 ($5,190 - $34,260)	$421,500	$630,467

D 8.5 Annual Expected Modification Cost Estimates

Based on the EPA's analysis, it is not certain that a facility will in fact incur modification costs. Their analysis focused on a relatively small sample of potentially affected facilities, specifically four major facilities and five minor facilities. The analysis reviewed site-specific monthly effluent and receiving water temperature data from these facilities to evaluate the effect of discharge on receiving waters. Based on this review, EPA concluded that one of the four major facilities would require significant capital expenditures along with incurring incremental O&M costs to comply. Of the five minor facilities, only one would incur incremental O&M costs, while the remaining four would experience no incremental costs.

These ratios are employed as the probabilities that a major and minor facility, respectively, will incur modification costs. Specifically, the analysis assumes that a major facility has a 0.25 probability of bearing modification costs (capital and O&M), and a minor facility has a 0.20 probability (O&M). The resulting annual expected modification costs are shown in Table D-28.

Table D-28 Estimated Annual Expected Per-Project Costs for NPDES-permitted activities			
Activity	**Sub-activity**	**Present Value of Costs**	**Annual Expected Cost**
NPDES-permitted activities	Minor facility	$72,039	$1,360
	Major facility	$630,467	$14,878

D 8.6 Assumptions and Potential Biases

Table D-29 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-29 NPDES-permitted Facilities: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
All states and related facilities are assumed to begin compliance with more stringent temperature requirements in the near term.	+
The sample of major and minor facilities (located in Oregon) considered in the EPA analysis is representative of facilities throughout the designation	+/-
The compliance costs estimated for the sample of facilities considered in the EPA analysis are representative for all facilities	+/-
The ratio of facilities affected by the new standard to facilities not affected in the EPA sample is representative of the ratio in the entire population of facilities.	+/-
All NPDES permit holders within the same class (major or minor) have a similar probability of incurring temperature control compliance costs.	+/-
- : May result in an underestimate of real costs + : May result in an overestimate of real costs +/- : Has an unknown effect on estimates	

D 9. Sand and Gravel Mining

D 9.1 Overview

- Sand and gravel mining activities that affect Pacific salmon and O. mykiss generally include the removal of gravel for industrial purposes, such as for road construction material, concrete aggregate, fill, and landscaping.[37]

- Sand and gravel mining is an activity permitted by USACE under sections 401 and 404 of the Clean Water Act, or under section 10 of the Rivers and Harbors Act of 1899.

- Section 7 consultations on sand and gravel mining have produced numerous recommended modifications, but one that is frequently recommended is a limitation that reduces the total amount of gravel that can be removed from salmon and O. mykiss habitat areas.

- This analysis applies an average per-mile cost of the net revenue forgone from sand and gravel mining due to section 7 restrictions in areas where sand and gravel mining affects critical habitat. This is likely to overstate the real costs of reducing sand and gravel mining within critical habitat, as alternative mining sites are likely to exist that would allow for substitution to sites outside of critical habitat.

- Impacts of section 7 implementation may be significant to the companies conducting activities within the riparian areas of this designation, though the overall impact of this activity on regional economies is likely to be smaller than other activities. This impact is not expected to result in a reduction in the overall market supply of gravel to the impacted regions.

D 9.2 Background

Sand and gravel is commonly mined from active river channels and floodplains for construction aggregate that can be made into concrete, asphalt, road base, and drain rock. Three basic types of sand and gravel mining can take place in salmon and O. mykiss habitat: wet-pit mining, bar skimming or scalping, and dry-pit mining. Wet-pit mining involves the use of a dragline or hydraulic excavator to remove gravel from below the water table and can directly destroy spawning habitat, increase turbidity, increase suspended sediment, and increase gravel siltation in salmon habitat areas. Gravel bar skimming typically occurs above the water table, but is also considered to significantly impact aquatic habitat by destabilizing the banks and increasing suspended sediment.[38] Dry-pit mining occurs outside the active stream channel, and typically is considered by NOAA

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[37] "NMFS National Gravel Extraction Policy," National Marine Fisheries Service, 2002 (NMFS Gravel Guidance)..

[38] NMFS Gravel Guidance.

Fisheries to have fewer direct effects on salmon and O. mykiss, although adverse impacts on the stream channel are still a concern.[39]

Sand and gravel mining is an activity permitted by USACE under sections 401 and 404 of the Clean Water Act, or under section 10 of the Rivers and Harbors Act of 1899, and this is the typical Federal nexus for consultation. This activity accounts for less than one percent of consultation on salmon and O. mykiss during 2001-2003. Several formal consultations are reported to be underway at present.

D 9.3 Cost Assessment

The sand and gravel mining extraction policy for NOAA Fisheries states that "gravel removal quantities should be strictly limited so that gravel accumulation rates are sufficient to avoid extended impacts on channel morphology and anadromous fish habitat."[40] Following this guidance, most NOAA Fisheries formal consultations on sand and gravel mining include strict gravel removal restrictions. The consultation record typically does not record the original quantities of gravel intended for a permit, however, so it is not possible generally to account for the opportunity cost of these restrictions. Instead, information from one case that has sufficient information to estimate this cost is applied.[41]

The case concerned a site mined for 32 years by Joe Bernert Towing.[42] The average annual gravel extraction for this area before the consultation was 281,000 cubic yards (cy). Under the terms of the biological opinion and resulting five-year USACE permit, the average annual removal allowed was 150,000 cy, a 47% reduction. This restriction imposed a loss of approximately 6,600 tons/mile on average for the site. At the current value of $6.70/ton,[43] the gross value of the forgone production is about $44,500 per mile annually.[44] If net revenue for this industry is assumed to be 25 percent of

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[39] Email communication with Erin Strange, NOAA Fisheries, Sacramento Office, December 9, 2003.

[40] NMFS Gravel Guidance. NOAA Fisheries is in the process of revising this guidance. The draft guidance has a statement almost identical to this one, however.

[41] Data on these costs were the most difficult to obtain, and it is likely that the one case for which cost data were available is an exceptional one. For that reason, this analysis makes assumptions in estimating costs that may need revision. NOAA seeks to improve the data for this estimate.

[42] Endangered Species Act Formal Section 7 and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Joe Bernert Towing Company Instream Gravel Mining Project, Lower Williamette River Basin, River Miles 27-56.6, Clackamas, Marion, and Yamhill Counties, Oregon (Corps No. 199601626), October 6, 2003.

[43] Kohler, Susan. "California Non-Fuel Minerals 2002." California Department of Conservation, California Geological Survey, Sacramento, California, 2002.

[44] It is possible that the life of the mine could preclude future mining at the same levels as previously, but this is not known.

gross revenue,[45] potential lost net revenues at this site are approximately $11,000 per year, or a present value of $1.35 million for the 30-mile mining area over the 5-year life of the permit.

Because substitute sites may be available to a producer, the actual loss in net revenues may be smaller than amount obtained assuming a substitute site is not used. Because critical habitat may cover a wide area, however, its coverage could create a need to travel a substantial distance to a substitute site, possible rendering the substitute site uneconomical.[46] Without information on the proximity of such substitute sites, it is assumed that net revenues lost to producers when gravel restrictions are imposed can be estimated in a manner similar to the one used above.

Because the area was mined successfully for 32 years, it is considered to be a good source of gravel. Clearly, not all sand and gravel mining areas will produce equivalent amounts of product. Moreover, the value per mile of sand and gravel mining activities depends on many factors, including depth of operation. Rough estimates of a few sample sites suggest that per-mile annual production may vary from 3,000 to 30,000 tons.[47] This analysis currently assumes that identified and currently-producing sand and gravel mining sites will produce gravel at rates similar to the ones in the above example.

D 9.4 Spatial and Temporal Distribution of Activity

This analysis identifies sand and gravel mining tracts in Oregon, Washington, Idaho, and California using latitude and longitude data from the USGS "Active mines and mineral plants" (1997). It assumes that each sand and gravel mining site in the areas under consideration will be involved in a consultation at some point over the next 30 years. The probability of consultation in a given year is assumed to be equal across that time period.

Whether or not a particular site will actually be required to modify its operations depends on many factors, including:

- whether the sand and gravel mining occurs in a salmon- or O. mykiss-bearing stream;
- the type of mining planned (wet-pit mining, bar skimming or scalping, and dry-pit mining)
- whether the planned mining activity will occur during spawning or migration of salmon; and
- whether the planned mining activity already incorporates mitigation measures to reduce sedimentation, bank stability, and channel widening.

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[45] This figure is a gross operating margin. RMA (Risk Management Association) Annual Statement Studies, 2002. NOAA is seeking better sources of information for this estimate.

[46] For every 30 miles that aggregate has to travel, the costs of transportation double. "California Again Leads the Nation in Production of Non-Fuel Minerals", California Department of Conservation, August 7, 2001.

[47] Estimated from sites characteristics included in "California Again Leads the Nation in Production of Non-Fuel Minerals", California Department of Conservation, August 7, 2001.

For this reason, this analysis considers that possibility that no modification will be required for a sand and gravel mining operation. Without more detailed information on the distribution of site attributes, an equal probability is assigned to the occurrence of the two possible events, modification and no modification. Moreover, it is also assumed that restrictions will be in effect for five years of the 30 year forecast period, after which a substitute site is used or some other alternative is chosen that eliminates the loss in net revenue.

D 9.5 Annual Expected Modification Cost Estimates

To derive the annual expected modification cost for sand and gravel mining, this analysis combines the cost estimates and assumptions in the following way:

1) If a consultation occurs and modifications are required, the cost of the modifications equals the lost net revenue over a five year period derived from the example above, or $1.35 million.

2) The probability that a consultation will occur in a given year is 0.033, and the probability that the modifications will be required is 0.50.

The resulting annual expected modification cost for sand and gravel mining is given in Table D-30.

Table D-30
Estimated Annual Expected Per-Project Costs for Sand and Gravel Mining

Activity	Sub-activity	Present Value of Costs	Annual Expected Cost
Sand and Gravel Mining	Mining on non-Federal lands	$1,353,065	$22,551

D 9.6 Assumptions and Potential Biases

Table D-31 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-31 Sand and Gravel Mining: Assumptions and Potential Biases	
Assumption	**Direction of Potential Bias**
This analysis assumes that each sand and gravel mining site in critical habitat is likely to bear costs associated with section 7 implementation for salmon and O. mykiss over the next 30 years, and assumes an equal probability of those costs being borne in any one year in that time period. Because site-specific characteristics vary, this is a conservative assumption.	+
This analysis assumes that substitutes are unavailable to sand and gravel mining companies who are required to reduce mining efforts in salmon and O. mykiss critical habitat areas.	+/-
Costs and impacts attributable to critical habitat designation for specific sand and gravel mining operations are not available. As a result, the cost/impacts identified are based on a small sample of projects, and may not precisely capture impacts incrementally attributable to critical habitat or section 7 of the ESA. In addition, impacts at specific projects are likely to vary.	+/-
This analysis assumes that a typical mining operation will be 30 miles of mining for 5 years, with a profit margin of 25 percent.	+/-
- : May result in an underestimate of real costs + : May result in an overestimate of real costs +/- : Has an unknown effect on estimates	

D 10. Residential and Commercial Development

D 10.1 Overview

- This analysis assesses impacts on residential and commercial development, but excludes impacts that are covered elsewhere (roads, utility lines, and so forth).[48] The most common Federal agencies involved in residential and related development consultation is USACE as they permit construction or expansion of

[48] Infrastructure impacts are captured in the analyses of transportation, instream, and utility line projects.

stormwater outfalls, discharge or fill of wetlands, flood control projects, bank stabilization, and instream work.[49]

- This analysis estimates the per-project cost of section 7 implementation on residential and related development projects as $235,000 ($230,000 to $240,000), using costs of implementing state recommended stormwater plans. The estimate includes costs of the stormwater pollution prevention plan, permanent stormwater site plan, and stormwater best management practice operation and maintenance.

- The designation of critical habitat for the Pacific salmon and O. mykiss is unlikely to have significant impacts to this activity by increasing costs to developers, reducing revenues, imposing mitigation costs, or resulting in project delays. The designation of critical habitat will have a negligible impact on regional market supply for residential, commercial, or industrial land and thus the primary impacts will be felt by individual property owners. There are three reasons significant impacts are not anticipated. First, the historical consultation record suggests that section 7 consultation regarding Pacific salmon and O. mykiss are rare. Second, the resulting project modifications are relatively small and/or have been captured by other activities (e.g., utility line activities). Third, the land markets in the proposed critical habitat area are relatively unconstrained (e.g., market substitution to competitive and comparable sites can easily occur). All of these factors contribute to a low impact to development.

D 10.2 Background

The potential for adverse economic impacts arising from constraints on residential and related development is a frequent concern to communities in which critical habitat has been proposed for designation. The nature and magnitude of any economic impact attributable to critical habitat designation will depend upon baseline land and housing market conditions and the extent to which a designation distorts these initial conditions. A common concern is that the designation of critical habitat may reduce the overall amount of land available to the market, and increase the price of developed land and housing.

If critical habitat designation inhibits the development potential of some parcels, the supply of land available for development will be reduced. In areas that are already highly developed, or where developable land is scarce for other reasons (i.e., non-critical habitat-related regulations), this reduction in available land and the corresponding increase in price could be significant, and ultimately translate into fewer housing units being built within the affected market, affecting both producers and consumers. In areas where developable land is relatively plentiful, however,

[49] Personal communication with DeeAnn Kirkpatrick, NOAA Puget Sound Habitat Conservation Division, Fishery Biologist Southern Puget Sound Region, October 31, 2003. Personal communication with Eric Shott, NMFS Santa Rosa Field Office Section 7 Coordinator, November 5, 2003. Personal communication with Gary Stern, NMFS Santa Rosa Field Office, San Francisco Bay Team Leader, November 5, 2003.

developers and builders will be able to identify substitute sites for projects, thereby limiting economic impacts to the owners of specific parcels that suffer a diminishment in their land's value.

In addition to the primary economic impacts identified above, additional categories of economic and financial effects are possible in residential and commercial development markets.[50] Regional economic impacts reflect changes in *local* output, employment and taxes. The principal category of regional impacts associated with critical habitat designation in areas of residential development involves potential changes in revenues and employment in construction-related firms and other industries that support builders and developers. Specifically, concern may arise that if development activity decreases in a given area, these secondary industries may suffer economic consequences.

A second category of regional impacts concerns the potential for forgone tax revenues associated with reduced residential development. That is, reduced development potential in an area may lead to lower real estate and other tax revenues.[51] It is important to note, however, that the *net* impact of any expected changes in tax revenues in affected communities. In many cases the change in revenue will be offset by an equal change in municipal expense; thus, it is important that any estimated impacts in this category are net of these service expenditures.

Finally, in more extreme cases, concern may exist regarding the broader impact of critical habitat designation on regional economies. Specifically, concern may exist regarding whether designation will delay and/or impair an area's ability to realize economic growth by influencing development patterns. Whether further development of a region is, on net, desirable is a point of contention in many markets. Nonetheless, with the exception of cases in which critical habitat designation precludes a large proportion of available land from development, designation is unlikely to substantially affect the course of regional economic development.[52]

In some cases, the public may believe that critical habitat designation will depress private property values below the levels associated with anticipated project modifications described above. That is, the public may perceive that, all else being equal, a property that is designated as critical habitat will be stigmatized and have lower market value than an identical property that is not within the boundaries of critical habitat. Public attitudes about the limits and costs that critical habitat may impose can cause real economic effects to the owners of property, regardless of whether such limits are actually imposed.

The designation of critical habitat for the Pacific salmon and O. mykiss ESUs under consideration is unlikely to increase costs to developers, reduce revenues, impose mitigation costs, or result in project delays, at least in significant amounts. There are two reasons significant impacts are not

[50] Elliott D. Pollack and Company, The Economic and Fiscal Impact of the Designation of 60,060 Acres of Privately Owned Land in Pima County, Arizona as Critical Habitat for the Cactus Ferruginous Pygmy-Owl, prepared for Southern Arizona Homebuilders Association, February 25, 1999.

[51] Ibid.

[52] Meyer, Stephen M. 1998. "The Economic Impact of the Endangered Species Act on the Housing and Real Estate Markets." New York University Environmental Law Journal. 6(450):1-13.

anticipated. First, the connection to section 7 consultation regarding the ESUs are limited to specific components of a development, and are expected to have no direct impact on the supply of land or housing. Second, as seen in the next part of this section, project modification costs are expected to be modest (anticipated to range from $230,000 to $240,000) and, according to NOAA Fisheries personnel, consultations regarding development projects are rare.[53]

For this reason, the available data also do not support an expectation of significant stigma effects. Section 7 has no strong historical connection to restrictions on private property, and there is no expectation that this lack of a connection will change in the future. If such stigmatization does occur, it seems likely that experience with the actual strictures of critical habitat designation will remove any (negative) premium that might be characterized as a stigma effect.

D 10.3 Cost Assessment

This analysis uses information from the Washington Department of Ecology as the basis for the cost assessment.[54] Table D-32 lists the typical modifications associated with development projects and presents a range of costs. To determine this range, all potential project modification costs were aggregated and this was applied as the average project cost to each project. This is likely to be an overestimate because it is the cost of implementing the State of Washington's suggested stormwater management plan and other states may not require as stringent standards as this plan. These costs are assumed to be borne in one year.

Table D-32
Estimated Per-Project Costs of Modifications for Development Projects

Activity	Typical Project Modifications	Estimated Costs
Residential and Related Development	- Implement state recommended stormwater plans. - Activities to reduce stormwater volume and/or pollutants. - Minimizing hardscape of the outfall structure. - Vegetation replacement.	$230,000 to $240,000

D 10.4 Spatial and Temporal Distribution of Activity

[53] Personal communications with DeeAnn Kirkpatrick, NOAA Puget Sound Habitat Conservation Division, Fishery Biologist Southern Puget Sound Region, October 31, 2003; Eric Shott, NOAA Fisheries Santa Rosa Field Office Section 7 Coordinator, November 5, 2003; and Gary Stern, NOAA Fisheries Santa Rosa Field Office, San Francisco Bay Team Leader, November 5, 2003.

[54] Washington Department of Ecology Year 2001 Minimum Requirements for Stormwater Management in Western Washington Cost Analysis, August 2001.

To estimate the volume and location of development-related impacts, EPA data on the volume and locations of State-issued NPDES stormwater permits and USACE permit data were used. Information from USACE permits for stormwater systems would be the ideal data, as they have information on location, cover development activities, and have a clear Federal nexus. Only one USACE district (Seattle), however, identified stormwater projects in their permit data. NPDES stormwater permits are overly inclusive, as not all State-issued permits are for projects which would require the modifications recommended by NOAA Fisheries (e.g., single family home would not require an extensive stormwater management system).

This analysis assumed that the ratio of the Seattle USACE stormwater permits (which have a clear Federal nexus) to State-issued NPDES stormwater permits in the area covered by the Seattle USACE district could be applied to other areas. This approach found 86 of the 104 NPDES stormwater permits issued by Washington Department of Ecology from 2000 to 2003 lay within the boundary of Seattle USACE jurisdiction. There were five unique stormwater permits identified in the Seattle USACE data from 2000 to 2003. This proportion (0.058 USACE-permitted stormwater projects per 1 State-issued NPDES stormwater permits) was then used to adjust the volume of State-issued NPDES permits for stormwater projects in a particular area.

In California, the facility city location was used from the Notice of Intent for Stormwater Discharges Associated with Construction Activities under a NPDES general permit from 2000 to 2003. This was done due to the large proportion (90 percent) of missing latitude and longitude points for NPDES permit locations in the NPDES spatial data. It is also assumed that areas of historic permits are likely sites for future construction or replacement of stormwater systems.

This analysis assumes that each development-related project is certain to bear these modification sometime during a 20 year period, and that the probability of occurrence is uniformly distributed over this period.

D 10.5 Annual Expected Modification Cost Estimates

As noted above, this analysis assumes all modification costs are certain and borne in one year, and that each development is certain to bear the costs during a 20 year period. These assumptions produce the annual expected modification costs shown in Table D-33.

Table D-33
Estimated Annual Expected Per-Project Costs for Residential and Commercial Development

Activity	Sub-activity	Present Value of Costs	Annual Expected Cost
Residential and Commercial Development	New development	$235,000	$11,750

D 10.6 Assumptions and Potential Biases

Table D-34 presents the key assumptions of the economic analysis for this type of activity, as well as the direction of potential bias introduced by the assumptions.

Table D-34
Development Projects: Assumptions and Potential Biases

Assumption	Direction of Potential Bias
State and local laws do not require similar provisions to the Minimum Requirements for Stormwater Management of Washington Department of Ecology.	+
Historic location of stormwater permits is the most reasonable predictor of future locations available.	+/-
Stormwater system costs for Washington Department of Ecology recommended systems are the most reasonable estimates of the cost of project modifications for development.	+/-
NOAA stormwater system recommendations do not overlap with state or local laws.	+/-
Other consultations related to development may occur through associated infrastructure and are captured in these other activities.	+/-

- : May result in an underestimate of real costs
+ : May result in an overestimate of real costs
+/- : Has an unknown effect on estimates

D 11. Summary

Table D-35 below summarizes the cost estimates for the different types of activities.

Table 4-2
SUMMARY OF ACTIVITY COST ESTIMATION

Activity	Sub-activity	Cost Unit	Midpoint Cost Estimate	Present Value of Cost Stream	Forecast Period	Likelihood of Modifications	Annual Expected Cost
Hydropower Dams*	Small (0 - 5 MW)	per dam	$2,120,000	$1,123,000	20 years	10% over 20 years	$10,600
	Medium (5 - 20 MW)		$5,750,000	1,915,868	50 years	100% over 50 years	$138,800
	Large (>20 MW), fish passage unknown		$56,390,000	$34,593,394	50 years	100% over 50 years	$2,506,632
	Unknown capacity		$7,530,000	$2,505,732	50 years	100% over 30 years	$181,565
Non-hydropower Dams	Federal and large non-hydropower dams	per dam	$2,120,500	$1,123,000	20 years	100% over 20 years	$106,025
	Small non-Federal Non-hydropower dams					10% over 20 years	$10,603
Federal Land Management Activities	Northern California	per acre	$8.95	$8.95	1 year	100%	$8.95
	Southern California		$12.16	$12.16			$12.16
Livestock Grazing on Federal Land	Grazing	per acre	$29.00	$20	10 years	100% over 10 years	$2.90

Table 4-2
SUMMARY OF ACTIVITY COST ESTIMATION

Activity	Sub-activity	Cost Unit	Midpoint Cost Estimate	Present Value of Cost Stream	Forecast Period	Likelihood of Modifications	Annual Expected Cost
Transportation**	Bridges & culverts (small)	per project & mile	$27,800 + variable costs (dependent on size of project)	project specific	5 years	100% over 5 years	project specific
	Bridges & culverts (medium)		$55,500 + variable costs	project specific			project specific
	Bridges & culverts (large)		$84,300 + variable costs	project specific			project specific
	Roads (small)	per project & mile	$22,800 + variable costs	project specific	5 years	100% over 5 years	project specific
	Roads (medium)		$47,000 + variable costs	project specific			project specific
	Roads (large)		$71,300 + variable costs	project specific			project specific
Utility Lines	Outfall structures and pipelines	per project	$101,000	$75,388	8 years	100% over 8 years	$12,625
Instream Activities	Dredging	per project	$821,000	$612,000	8 years	100%	$102,325
	Dredging of San Francisco Bay	per project	$651,000	$485,914	8 years	100%	$81,375
	Boat dock, boat ramps, bank stabilization	per project	$54,500	$40,679	8 years	100%	$6,813

Table 4-2
SUMMARY OF ACTIVITY COST ESTIMATION

Activity	Sub-activity	Cost Unit	Midpoint Cost Estimate	Present Value of Cost Stream	Forecast Period	Likelihood of Modifications	Annual Expected Cost
EPA Water Quality Temperature Compliance	Minor facility	per facility	$136,000	$72,039	20 years	20%	$1,360
	Major facility	per facility	$816,000	$630,467	20 years	25%	$14,878
Sand and Gravel Mining	Mining on non-Federal lands	per site	$800,000	330,908	30 years	50% over 30 years	$13,333
Residential and Commercial Development	New development	per project	$235,000	$124,480	20 years	100% over 20 years	$11,750

*Data for hydropower dams do not allow allocation of all costs over an expenditure period. The cost stream presented is the present value of costs.
**Transportation costs are presented for a project of average mileage (3.2 miles).